The Kingdom of Cambodia
Electricite Du Cambodge

The Project for Construction and Rehabilitation of Small Hydropower Plants in Rattanakiri Province

Basic Design Study Report

March 2013

Japan Internatioanl Cooperation Agency

Electric Power Development Co., Ltd.
Chuden Engineering Consultants Co., Ltd.
Chugoku Electric Power Co., Inc.

PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Electric Power Development Co., Ltd., Chuden Engineering Consultants Co., Ltd. and Chugoku Electric Power Co., Inc.

The survey team held a series of discussions with the officials concerned of the Royal Government of Cambodia, and conducted a field investigation. As a result of further studies in Japan, the present report was finalized.

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

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

March, 2013
Hidetoshi IRIGAKI
Director General,
Industrial Development and Public Policy Department
Japan International Cooperation Agency

Executive Summary

The Kingdom of Cambodia (hereinafter referred to as "Cambodia") is a country that lies between latitudes 10N˚ and 15˚N, and longitudes102E˚ and 108˚E. It is located in the southern portion of the Indochina Peninsula, bordered by Vietnam to the east, Thailand to the west, Laos to the north, and the Gulf of Thailand to the south. Cambodia has an area of 181,035 km^2 with a population of 14.31 million (2011, World Bank) and a nominal GDP per capita of US$900 (2011, World Bank). The central region of around 50-meter elevation or lower, which occupies most of Cambodia's land area, is a floodplain of the Mekong River that flows from north to south and the Tonle Sap (Great Lake) in the northwestern part of the country. The central plain is surrounded by hilly terrains along the borders.

Rattanakiri Province, where the Project site lies, is located in the northeastern hills bordering Vietnam and Laos. It has a land area of 10,782 km^2 with an annual precipitation of 2,154 mm and the highest and lowest temperatures of 32.3˚C and 22.7˚C, respectively. Rattanakiri is a mostly agricultural province with a population of 150,000, which has been growing recently (at an annual rate of 4.67% or higher). While the electrification rate of the province is around 16%, it has a high potential for small hydro development because of its mountainous topography and abundant water resources.

The Rattanakiri Office of the Electricite Du Cambodge (EDC) is supplying electricity to the province (including wholesale to local power distribution companies). The number of households receiving electricity increased 1.24 times from 2007 to about 3,200 homes in 2011, and the power sold during the same period rose 2.25 times to 8,649,052 kWh. Since the demand is far exceeding the supply capacity of EDC's Rattanakiri Office, the province relies approximately 80% of its power supply on import from Vietnam. The province experienced 146 power outages, or a total of 560 hours and 17 minutes of interruption, during a one-year period from August 2011 to July 2012. This figure is extremely high compared to the Mondulkiri grid system built in Cambodia under Japan's grant aid, which only had 18 outages in 2009, 7 in 2010, and 1 in 2011.

The O'Chum No.2 Power Station, which has been in operation since 1993, can currently output only about 820 kW despite its nameplate capacity of 960kW. This is due to damaged runner vanes and expanded runner-seal gap caused by cavitation of the water turbines from many years of operation. The water turbines and generators have also severely deteriorated from age, which could lead to an increasing number of accidents. In addition, the guide vanes, which regulates the amount of water used for power generation, have been operated manually based on the experience and intuition of the operators without any civil engineering drawings, design calculation book, operation manual, or other documents needed for proper operation and maintenance of the power plant.

Under these circumstances, the Government of Cambodia formulated a plan to redevelop the existing O'Chum No.2 Power Station in Rattanakiri Province and requested the Government of Japan to extend a grant aid to fund the associated expenses.

In response to the above request, the Government of Japan decided to conduct a preliminary survey, and the Japan International Cooperation Agency (JICA) dispatched a Preparatory Study Team to Cambodia for a period between July 29 and August 27, 2012 to discuss with the relevant Cambodian personnel about the contents of the request and the proposed Project, as well as to survey the Project site and collect pertinent data and documents. Subsequently, an additional survey was conducted from September 19 to October 3, 2012 to study matters related to the equipment renewal at the existing O'Chum No.2 Power Station.

Upon return to Japan, the Study Team examined the necessity, socio-economic effects, and viability of the proposed Project based on the data and documents collected in the field surveys, and summarized the basic design and the implementation plan into a Preparatory Study Report (draft). JICA then dispatched the Study Team to Cambodia again to present and explain the Basic Design Study Report (draft) from December 9 to 22, 2012.

We defined the scope of cooperation as follows. For the O'Chum No.1 Power Station (output: 265 kW), we will construct a new penstock and power station while reusing/renovating the existing O'Chum No.1 Dam and incidental works (water intake/discharge facilities) without building a new dam. For the O'Chum No.2 Power Station (output: 960kW), we will renew the hydropower generation equipment, including the turbines and generators, while continuing to use the existing dam, intake, gates, penstock, power plant building, and other civil-engineering/mechanical equipment by performing repair work as necessary.

In designing the O'Chum No.1 Power Station, we took into consideration the fact that, although an unused head of about 23 meters exists between the O'Chum No.1 and No.2 Dams, there is an 8-meter drop waterfall between the two dams, which has become a place for relaxation and refreshment for the local residents. For this reason, we decided to construct the new power station upstream of the waterfall, even though it would reduce the usable drop in half, in order to preserve the landscape and prevent river-drying and other environmental impacts. In addition, we will build the power station within the land owned by EDC in order to avoid the acquisition of private properties and substantial alteration of land. The renewal of the O'Chum No.2 Power Station will not cause additional impact on the environment, as the renewed equipment will be installed in the same location without changing the intake method or water volume. Table 1 below shows the main facilities.

Table 1　Outline of Main Facilities

Name of facility	Contents
O'Chum No.1 Power Station (new construction)	Intake : concrete structure, height 7.15 m、width 2.20 m Penstock : diameter 1.0～1.5 m, length457　m Turbine : cross-flow, 295 kW Generator : 3 phase AC induction generator, 350 kVA Installed Capacity : 265 kW Power House : 1-story with floor area of 64 m^2 Adminisrative Road : 624 m, width: 4.0m (3.0 m travelled width + 0.5 m shoulder × 2), low-cost pavement
O'Chum No.2 Power Station (equipment renewal)	Turbine : horizontal shaft francis, 507 kW × 2 units Generator : 3 phase AC brushless synchronous generator, 600 kVA × 2 units Installed Capacity : 480 kW ×2 units (total 960 kW) Adminisrative Road : length: 383 m, width: 5.0 m (4.0 m travelled width + 0.5 m shoulder × 2), low-cost pavement
Transmission/ distribution Line (new)	22 kV medium-voltage distribution Line, length: 730 m

The approximate cost of implementing this proposed Project under Japan's grant aid is estimated at XXX billion yen. The cost to be born by the Cambodian side is estimated at about 1 million yen to cover banking arrangement fees. The project period will be around 24 months, comprised of about 7 months for detailed design and tender procedure and about 17 months for facilities construction and trial operation.

EDC, the execution agency of this Project, is Cambodia's only state-owned electric power company engaged in the transmission and distribution of electricity within the country staffed by a total of 2,760 employees as of 2011. EDC's Rattanakiri Office in Rattanakiri Province, where the site of this Project is located, employs 44 staff members, of which 7 work in the power generation department. The Rattanakiri Office will be in charge of the operations and maintenance of the O'Chum No.1 and No.2 Power Stations to be covered by this Project, which will construct a new power plant at the O'Chum No.1 Power Station and renew the equipment of the existing O'Chum No.2 Power Station. As a result, the control devices and other equipment of the existing facilities will be replaced with the latest equipment, and the operators will need to acquire a new set of skills for their management, as well as for efficiently coordinating the operations of the two power stations, which will be built on a terraced terrain. For this reason, we decided to follow up on this Project with a soft component (technical assistance) to transfer operations/maintenance techniques to the operators.

The construction of a new small power station and the renewal of the existing small power station will provide reliable power supplies and diversify energy sources in rural regions, thereby contributing to the socio-economic development of Cambodia and the reduction of greenhouse gas emissions. Other expected benefits include the dissemination and promotion of small hydropower development in Cambodia, as well as the acquisition and improvement of know-how and techniques for the operations/administration of reservoirs and power stations.

As mentioned above, this Project, which is operable and maintainable well within the organizational/personnel/financial capacities of EDC, is expected to have a significant positive impact on the electric sector of Cambodia. Therefore, it is deemed appropriate to implement this Project under Japan's grant aid.

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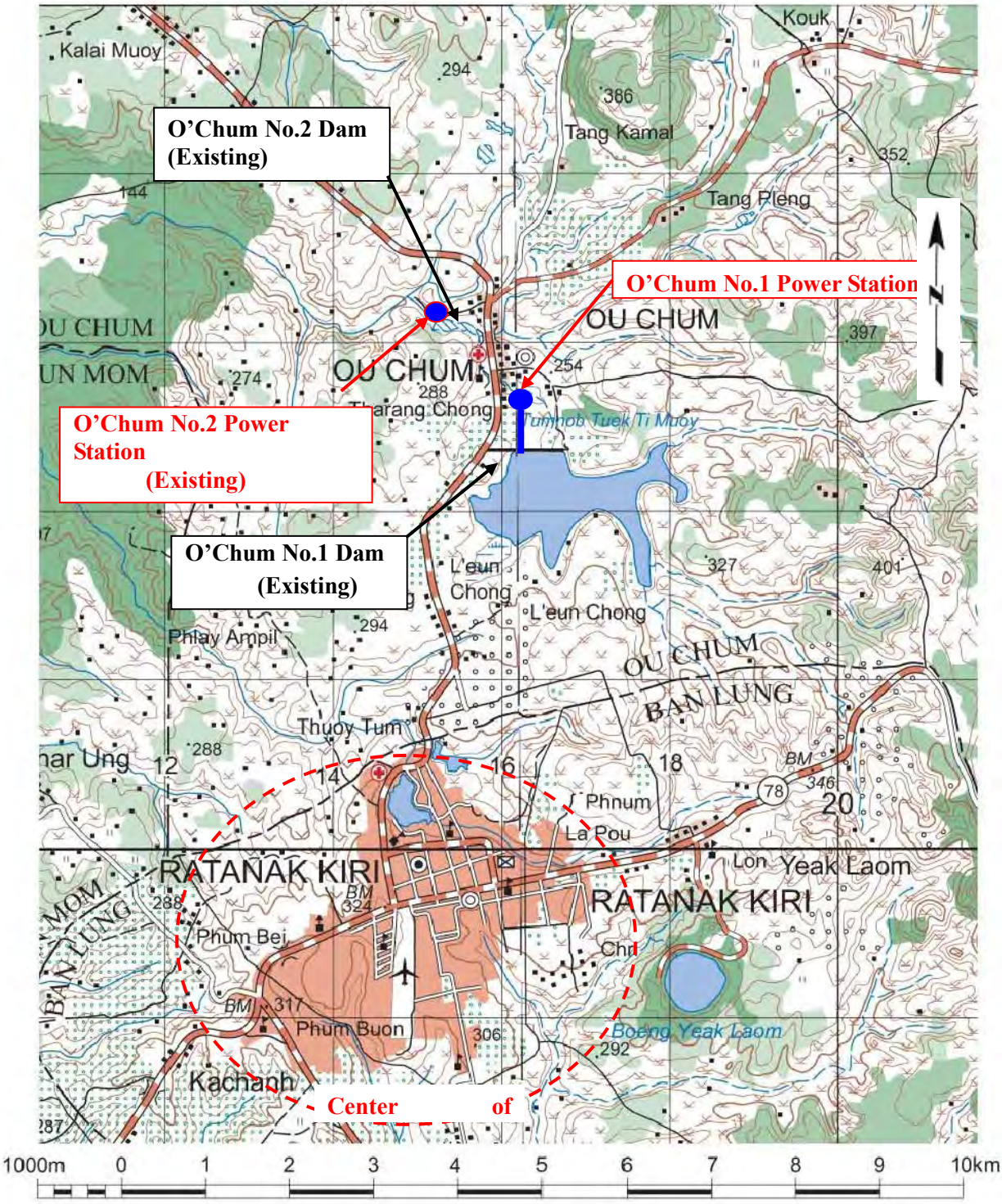
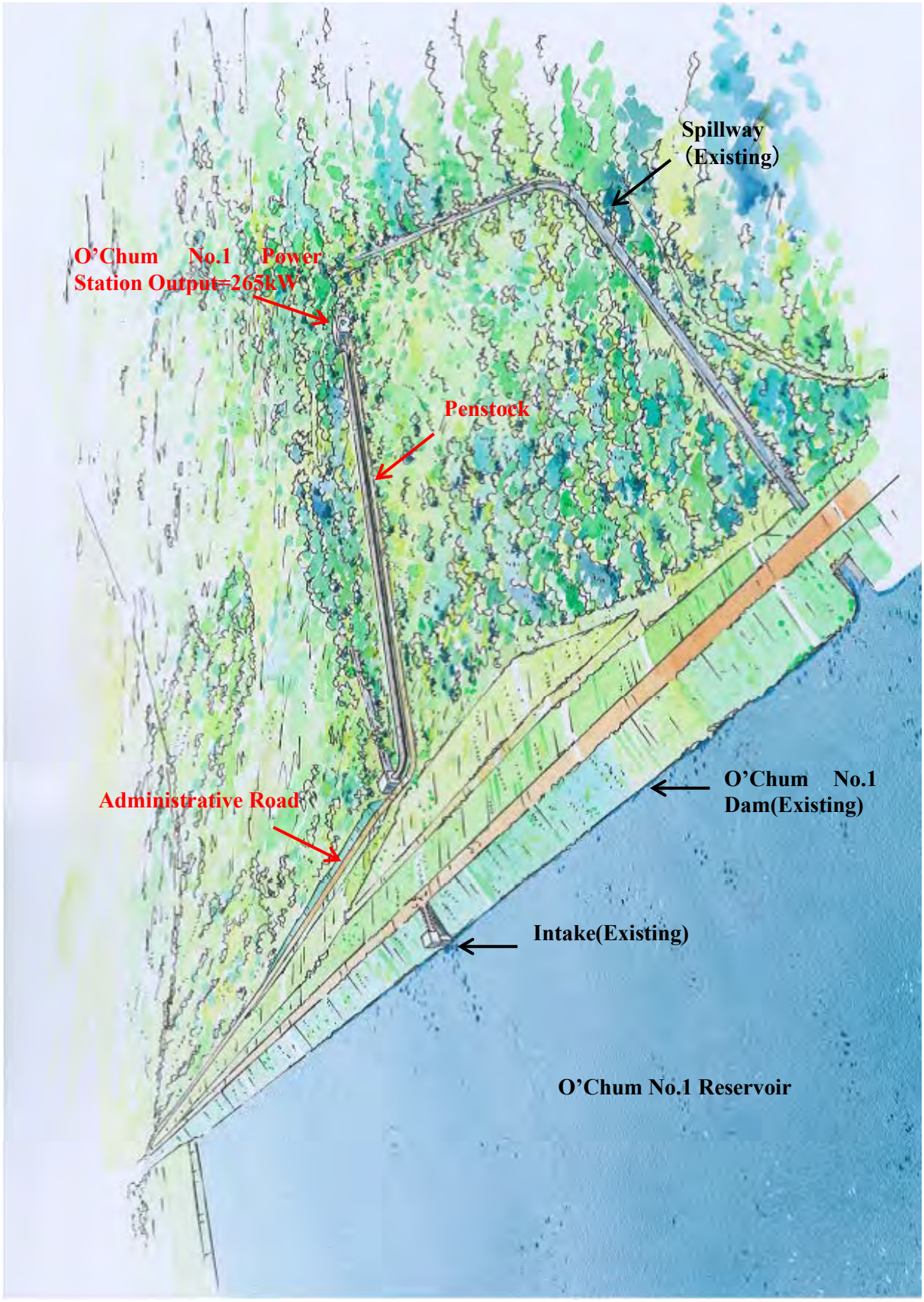
Source://www.lib.utexas.edu/maps/asia.html

Location of Rattanakiri Province



Location Map of Power Stations



Forecast Image for O'Chum No.1 Power Station

Photos Showing the Conditions of Existing Facilities

(1) Existing reservoir of the O'Chum No.1 Dam (rainy season): has a total reservoir capacity of 13.1×106m3 and full water level of 291.5m. It was constructed in 1993 to supplement water supplies during the dry season to the existing O'Chum No.2 Power Station situated 2km downstream of this dam.

(2) Existing reservoir of the O'Chum No.1 Dam (dry season): empties out after supplying all the stored water to the existing power plant. This kind of condition will be eliminated by the construction of the new O'Chum No.1 Power Station, after which the lowest water level will rise to 8m.

(3) Intake tower of O'Chum No.1 Dam: severely deteriorated due to absence of maintenance. The gate will be renewed, as it is not operating properly and its water-shielding function failing.

(4) Spillway of O'Chum No.1 Dam (overflow style): According to the downstream flood marks, water is probably discharged a few times a year at around 4 - 5m3/s, though the exact frequency and rate of discharge are unknown due to absence of discharge record.

(5) Panoramic view of downstream side of Dam: The white building at left is a release-valve room. The new power plant will be constructed at far right and connected to the valve room with an exposed penstock.

	
(6) Dam crest road: Not open to general vehicles, but used by motorcyclists and pedestrians as a community road.	(7) O Anh Juch Waterfall: An 8-meter drop waterfall provides a place of refreshment and relaxation for local residents. The scheduled construction site of the new power plant is 60m upstream of this waterfall.
	
(8) Spillway of O'Chum No.2 Dam: Though nearly 20 years old, its structural integrity has not been compromised.	(9) O'Chum No.2 Power Plant Building: Can generate only 820kW despite its nameplate output of 960kW due to deteriorated equipment.
	
(10) O'Chum No.2 Power Station, whole view of turbines and generators: The near side is Unit No.2, and the far side is Unit No.1. Operators work in 3 shifts, 1 in each shift and 4 during the day shift, to generate power.	(11) O'Chum No.2 Power Station, condition of generator: The exciter is severely deteriorated due to aging. Turbine has cavitation and is worn out.

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Abbreviatioin

ADB	Asian Development Bank
E/N	Excahange of Note
EAC	Electricity Authority of Cambodia
EDC	Electricite du Cambodia
EIA	Environmental lmpact Assessment
G/A	Grant Agreement
GDP	Gross Domestic Product
IEC	International Electrotechnical Commission
IEIA	Initial Environmental Impact Assessment
IPP	Independent Power Producer
ISO	International Organization for Standardization
JEC	Japanese Electrotechnical Committee
JEM	Standards of Japan Electrical Manufacture's Association
JICA	Japan International Cooperation Agency
MIME	Ministry of lndustry, Mines and Energy
MOE	Ministry of Environment
NGO	Non-Government Organization
TOR	Term of refenrece

1. Background of the Project

1.1 Present Conditions and Challenges of the Relavant Sector

1.1.1 Present Conditions and Challenges

In Rattanakiri Province, where EDC's Ratanakiri Office is supplying electricity (including wholesale to local power distribution companies), the number of households receiving electricity increased 1.24 times from 2007 to about 3,200 homes in 2011, while the power sold during the same period jumped as much as 2.25 times to 8,649,052 kWh. Since the demand is far exceeding the supply capacity of EDC's Rattanakiri Office, the province relies about 80% of its power on import from Vietnam[1]. The province experienced 146 power outages, or a total of 560 hours and 17 minutes of interruption, during a one-year period from August 2011 to July 2012. This figure is extremely high[2] compared to the Mondulkiri grid system built in Cambodia under Japan's grant aid, which only had 18 outages in 2009, 7 in 2010, and 1 in 2011. About two-thirds of the outages were due to accidents or construction work in Vietnam, while 10 outages were caused by equipment failures on the Cambodian side. When there is construction work on the Vietnamese side, power supply to Banlung City, the provincial capital, is usually sustained by supplemental supply from the O'Chum No.2 Power Station, while Ou Ya Dav and Bar Kaev Districts along the National Route 78 always experience outages because of limited supply.

In addition, the existing O'Chum No.2 Power Station, which began operation in 1993, can generate only 820 kW despite its nameplate output of 960 kW. This is due to damaged runner vanes and expanded runner seals caused by cavitation in the turbines from many years of operation. The turbines and generators have also severely deteriorated from age, which could lead to an increasing number of accidents. Moreover, the operators have been manually controlling the guide vanes to control the water volume used for power generation by relying on experience and intuition in a work site, where there are no engineering drawings, design calculation sheets, operation manuals, or other documentation necessary for the proper operation and maintenance of the power station.

1.1.2 Development Plan

The Royal Government of Cambodia made "National Strategic Development Plan 2009-2013" and held up in the electric power development as follows;

1. securement of the electric power supply
2. moderation of electricity tariff
3. enhancement for electric power organizations and capacity building

In 2006, the Royal Government of Cambodia also made "Promotion and Strategy Plan for Rural

[1] Based on record from June 2011 to July 2012

[2] It should be noted that the medium-voltage cable of the Mondulkiri grid system is 27.8km long and shorter than the that of the Rattanakiri grid.

Electrification" as follows;

1. 100% of village would be electrified including battery illumination by 2020
2. 70% of household would be electrified supplied from power grid by 2030

In order to achieve these targets, Cambodian government enforced "Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia" (SPDRE) as Ministerial order (PRAKAS) in November 2011. In the introduction in SPDRE, "To continue to develop the power sector and to meet the ever increasing day to day demand efficiently at an appropriate tariff" is recognized as a crucial agenda. To address this agenda, promotion of the following is mentioned.

- Development of electricity generation plants using indigenous as well as reliable imported resources such as hydro resources, natural gas, and coal
- Use of renewable energy sources
- To continue to import electricity from neighboring countries

1.1.3 Social and Economic Situation

The planned construction site for the power plant in this project is located in O'Chum District and the generated power is expected to be supplied to Banlung District, Bar Kaev District and O Ya Dav District in addition to O'Chum District. The population of Rattanakiri province accounts for 1.1%[3] of the population in Cambodia, out of which approximately 52% is the population of these districts. While the population increase rate is 1.54% in Cambodia as a whole, it is 4.67% in Ratanakiri province, which is much higher than its increase rate in Cambodia 3. Main social/economic statistics in this area are as below.

[3] Population census in 2008

Table 1.1.3-1 Statistics in the Targeted Area

Item	Unit	Rattanakiri	Banlung District	O'Chum District	Bar Kaev District	O Ya Dav District
Area (2009)[4]	ha	843,132	19,292	53,098	50,626	16,138
Population (2011)[5]	Person	163,679	26,463	20,863	21,542	16,965
Number of household (HH) (2011)[5]	HH	34,950	5,686	4,724	4,309	3,596
Population by industry[6]						
Primary industry (2011)	Person	58,067	3,139	8,727	8,127	7,827
Secondary industry (2011)	Person	270	183	2	0	0
Tertiary industry (2011)	Person	4,405	2,310	125	276	505
Electrification ratio (2008)[7]	%	16	75.0	5.3	18.3	12.8

(Source: see footnotes)

As the economic activity, the ratio of primary industry is predominantly high in the whole Rattanakiri province in terms of the employed. (Approximately 93%) On the other hand, tertiary industry (approximately 41%) is as high as primary industry in the provincial capital, Banlung district. In this tertiary industry, "Trader" accounts for the highest proportion. In the rest of districts, O'Chum, Bar Kaev and O Ya Dav districts, the employed in primary industry is the highest in employment. In this primary industry, many employed engage in rice production in O'Chum and O Ya Dav, while many employed engage in production of other crops in Bar Kaev. In terms of the percentage of people living in poverty, it is 46.11% in Rattanakiri province (as of 2004)[8] and this percentage is high even as the one in Cambodia.

1.2 Project Background and Circumstances

In the Kingdom of Cambodia, electric power demand such as peak demand and also energy had been increasing more than 20% annually from 2003 to 2008. On the other hand, imported energy in Cambodia accounts for 61.5% and 91% of domestic generated energy is mostly supplied from independent power producers which are mainly small scale of diesel power plant. Consequently power generation cost in Cambodia is higher than neighboring countries. Moreover, electric power system in Cambodia also is not interconnected with whole country, which causes insufficient of electricity of quality and quantity in rural area especially.

Regarding electrification rate, urban area is 87% (2008), as against 13% (2008) in rural area.

4 NCDD Ratanak Kiri Data Book 2009

5 Commune Database 2011

6 Prepared based on Commune Database 2011. However, the figures may not be exhaustive, since they are the sum of head-counts in occupations of which the statistics are available.

7 Figures except Rattanakiri province level are taken from "Houses with electricity" in "NCDD Ratanak Kiri Data Book 2009". The figure for Rattanakiri province level is from the number of household connected to "City power" in Population census in 2008.

8 A poverty Profile of Cambodia 2004 Ministry of Planning 2006

The Royal Government of Cambodia made "National Strategic Development Plan 2009-2013" and held up in the electric power development as follows;

1. securement of the electric power supply
2. moderation of electricity tariff
3. enhancement for electric power organizations and capacity building

In 2011, the Royal Government of Cambodia also made "Promotion and Strategy Plan for Rural Electrification" as follows;

1. 100% of village would be electrified including battery illumination by 2020
2. 70% of household would be electrified supplied from power grid by 2030

Rattanakiri province which is located at the northeast of the country near the Vietnamese border, has a population of 150,000 and high growth rate of population. (4.67% per annum) and main industry is agriculture.

Electrification rate in Rattanakiri province is low of 16% comparison of other area, but has a great potential of micro hydropower project because of mountainous topography and abundant water resources.

Based on the above mentioned circumstances, the Royal Government of Cambodia planed for electrification promotion of agricultural village by O'Chum hydropower project in Rattanakiri province and made a request for Grant Aid for the project.

This preparatory survey is carried out within the frame of FY 2012 budget request for the "Promotion of Green Growth (project for the adoption/promotion of new energies)" in accordance with the policies of the Government of Japan. For this reason, the design policy and other specifics of the Project will be examined and determined on the premise that it will utilize excellent products and technologies of mainly small-to-medium-sized companies in Japan.

1.3 Trend of Japanese Assistance

Tables 1.3-1 and 1.3-2 respectively show the past technical cooperation and grant aid projects related to small hydropower generation that have been implemented by Japan for Cambodia's electricity sector.

Table 1.3-1 Japan's Past Technical Cooperation Projects (Small hydropower Sector)

Type of cooperation	Implementation year (FY)	Name of project	Outline
Development planning study-type technical cooperation	2002-2003	Study for Establishment of Electric Power Technical Standards and Guidelines	Establishment of "electric power technical standards" covering the 6 sectors of thermal power, power transmission/transformation, power distribution, hydropower, renewable energy, and internal wiring.
	2008-2009	Follow-up Study on the Study for Establishment of Electric Power Technical Standards and Guidelines (Regulations for the Development of Technical Standards for (Hydro) Electric Power)	Establishment of rules and regulations for the development of technical standards for hydropower generation.
Technical cooperation	2008-2010	Project for the Operation and Maintenance of the Mondulkiri Province Small Hydroelectric Project for Rural Electrification	Transfer of techniques for the operation and maintenance of the Hydroelectric Project constructed by grant aid.
Expert dispatch	2011	Expert dispatch to follow up on the Project for the Operation and Maintenance of Small Hydropower Station in Mondulkiri Province	A follow-up on the above technical cooperation project.

Table 1.3-2 Japan's Past Grant Aid Project (Small Hydropower Sector)

Implementation year (FY)	Name of project	Grant limit (100 million yen)	Outline
2006-2008	Mondulkiri Province Small Hydroelectric Project for Rural Electrification	11.03	Construction of a small hydropower station (370kW) and a thermal power station (300kW) to facilitate electrification of Mondulkiri Province.

1.4 Assistance Activities of Other Donor Organizations

There are no other assistance projects (completed or underway[9]) related to small hydropower development in Cambodia.

[9] As of August 2012

2. Present situation of Electric Power Sector

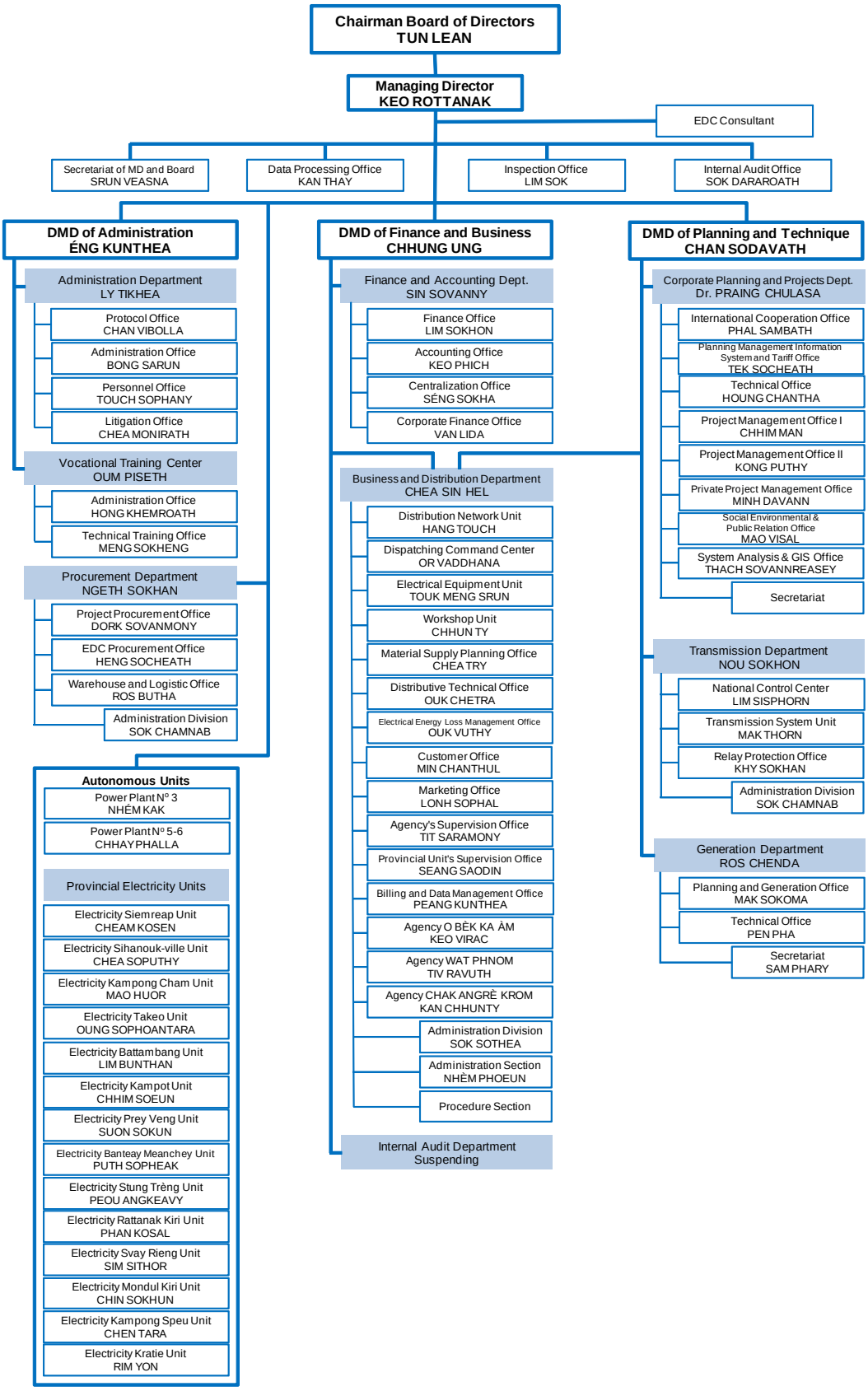
2.1 Implementation Organization of the Project

2.1.1 Organizations and Institutions in Electric Power Sector in Cambodia

Ministry of Industry, Mines and Energy(MIME） is responsible to formulate the energy policy, the strategy of electric power sector, power development plan and technical/safety/environmental standards in Cambodia.

While MIME is in charge of formulating policies, strategies and plans for electric power sector, Electricity Authority of Cambodia (EAC) is responsible to regulate and supervise in order for electricity to be supplied efficiently and stably. For this purpose, EAC will issue regulations and licenses to electric power providers, approve the tariff, settle disputes and impose penalties.

This project's implementation entity, EDC, is the only state-owned power corporation (Limited Liability Company) and plays the role to generate and transmit electricity in Cambodia. As of 2011, the staff is 2,760 in the whole EDC and the organizational chart is as follows:



(Source: "EDC Annual report 2012" draft version)

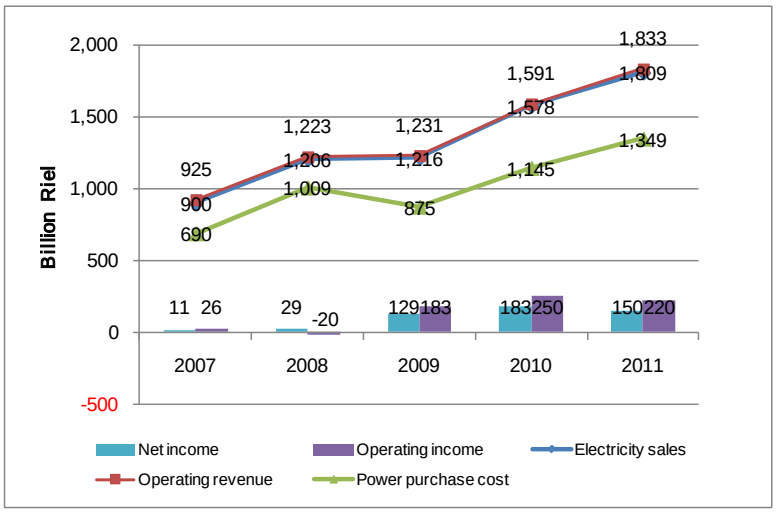
Figure 2.1.1-1 EDC Organizational Chart

EDC Rattanakiri Office in Rattanakiri where this project is located has 44 staff and 7 staff belongs to Generation Section.

O'Chum No.1 & No.2 Power Stations are planned to be managed by EDC Rattanakiri and present organizational chart is shown in Figure 3.4.2-1.

2.1.2 Financial Situation

For the whole EDC, operating revenue from electricity business is on the rise along with the electricity demand growth. On the other hand, the purchased power cost accounting for 80% of operating expense is also increasing in order to cover this electricity supply. However, the net income is in the increasing trend. (The operating profit in 2008 was in deficit along with the rapid increase of the purchased power cost and so on, but the net income was still in surplus due to loss compensation by the government.)



(Source: prepared by JICA survey team based on EDC Annual Report 2011, financial statements in 2012 and "Data collection survey on electric power sector in Cambodia: final report")

Figure 2.1.2-1 Highlight from EDC HQ Income Statement

On the other hand, the net income of EDC Rattanakiri Office is in deficit by 3,632 million Riel (approximately US$908,033) and 1,379 million Riel (approximately US$344,864) in 2010 and 2011, respectively. Even though the net income was in deficit in both of 2010 and 2011, the deficit in 2011 is less than the half of the one in 2010.

Table 2.1.2-2 EDC Rattanakiri Office Financial Data (Unit: 1000 Riel)

Year	2010	2011
Operating revenue		
Electricity sales	5,036,232	5,834,307
Others	86,813	540,049
Operating revenue	5,123,046	6,374,356
Operating expense		
Power purchase cost	6,786,746	4,682,578
Personnel	449,426	684,651
Fuel	0	0
Maintenance	184,322	204,017
Depreciation	531,793	831,875
Import duty	0	100,377
Others	826,064	1,178,561
Operating expense	8,778,351	7,682,059
Operating income	-3,655,305	-1,307,703
Non-operating income	72,405	374
Extraordinary income	243	-12,378
Income before income tax	**-3,582,656**	**-1,319,707**
Income taxes	49,476	59,751
Net income	**-3,632,132**	**-1,379,457**

(Source: Prepared by JICA survey team based on un-audited financial statement for EDC Rattanakiri Office.)

This reduction of the deficit is largely due to changing electricity suppliers from the local IPP to the import from Vietnam. According to the information obtained from the interview, the electricity from the local IPP was about 1,300 Riel/kWh (32.5 cents/kWh), while the one from Vietnam is about 276 Riel/kWh (6.9 cents/kWh). Therefore, the unit cost for purchased power was greatly reduced by changing to the import from Vietnam. (The tariff from Vietnam (except tax) was 6.9 cents/kWh in 2011. In 2012, it was increased to 8.36 cents/kWh.)

On the other hand, finance for EDC's each office is not independent on its own; therefore, O&M cost for equipment to be installed in this project is planned by Rattanakiri office in the previous year and HQ will bear the cost subject to HQ's approval of the plan. Therefore, even though EDC Rattanakiri office's net income is in deficit, HQ will not have problems to ensure the necessary cost, since the net income for EDC as the whole is in surplus of US$32 to 46 million in the past three years. Furthermore, even if EDC HQ falls in deficit, the government is supposed to compensate the losses. Thus, the possibility is slim that the O&M for this project falls into troubles due to the shortage of money.

2.1.3 Technological Level for Hydropower Generation

EDC currently owns three hydropower plants: O'Chum No. 2, O'Moleng and O'Romis power stations. All of them were constructed with overseas assistance. Thus, there is no hydropower plant that was developed solely by Cambodia. Although they have a certain level of maintenance capability at the

three hydropower plants, they operate them manually and thus they are not equipped with latest operation techniques. Partly because development plan, design and construction supervision were all conducted with overseas assistance, they have no accumulation of related technologies and it is essential for the EDC to acquire a certain level of technology of development plan, design, construction supervision and maintenance.

If the Project is actually implemented, EDC should be actively involved in development plan, design and construction stages to improve its technological capability.

2.1.4 Existing Facilities and Equipment

The O'Chum No.2 Power Station a hydropower station owned by EDC, is located in the northeastern region of Cambodia and comprised of an upstream dam (O'Chum No.1 Dam) and a downstream dam (O'Chum No.2 Dam). The water intake facility is built in the downstream dam, while the upstream dam stores water during rainy season to provide water to the downstream dam during dry season, when the river flow is low, to supplement water supply.

O'Chum No.2 Power Station was constructed in cooperation with Vietnam and completed in 1993, and almost twenty years have passed since the completion. Because this power station hasn't been maintained well, it is cleared that the present output of this power station was almost 820kW at best even though the rated output is 960kW. The main reason is supposed to be deterioration of the turbine efficiency brought by damage of the runner vane and/or expansion of the runner seal due to cavitation. In addition, deterioration of bearing of turbine/generator due to long period operation are also suspected the efficiency decrease to be part of the reason that the existing O'Chum No.2 Power Station cannot generate electric power at the rated output. And, although there is nothing to directly do with the deterioration of the efficiency of the turbine and generator, it is found that deterioration of excitation of the generator and some control panels are damaged and that some auxiliary machines deteriorate significantly. Judging from the above, the existing electro mechanical equipment including control panels and auxiliary devices shall be replaced with new one.

Existing data of electric facilities are as follows;

Turbine output	:	480 kW
Turbine type	:	Horizontal shaft francis turbine
No. of turbine	:	2 units
Rotating speed of turbine	:	750 rpm
Discharge	:	1.875 m^3/s (per unit)
Effective head	:	31 m
Generator output	:	600 kVA
Generator type	:	Horizontal shaft 3 phase synchronous generator
Rotating speed of generator	:	750 rpm

2.2 Conditions of the Project Site and Surrounding Areas

2.2.1 Infrastructure

The equipment and supplies to be procured from Japan for the construction of the O'Chum No.1 Power Station and the renewal of the O'Chum No.2 Power Station will be unloaded at the Sihanoukville Port and transported by land (via a regular route using National Routes 4, 6, 7, and 78) to a storage site in Banlung City, Rattanakiri Province, which is about 793km from the Sihanoukville Port. Because all of these national routes have relatively gentle grades and are paved and mostly in good condition, the travel time between the Sihanoukville Port and the site is estimated at two days.

The O'Chum No.1 Dam is located about 5km from the central district of Banlung City. The existing O'Chum No.2 Power Station is 2.0km away from the O'Chum No.1 Dam. Both sites are connected to Banlung City by National Route 78A. A section of the administrative road leading to the existing O'Chum No.2 Power Station has been eroded by water, making it difficult for vehicles to travel on this portion of the service road of about 370 m.

2.2.2 Geographical Conditions

Cambodia lies between latitudes 10˚N and 15˚N, and longitudes102˚E and 108˚E. It is located in the southern portion of the Indochina Peninsula, bordered by Vietnam to the east, Thailand to the west, Laos to the north, and the Gulf of Thailand to the south. Cambodia has an area of 181,035 km^2 with a population of 14.31 million (2011, World Bank) and a nominal GDP per capita of US$900 (2011, World Bank). The central region of around 50-meter elevation, which occupies most of Cambodia's land area, is a floodplain of the Mekong River that flows from north to south and the Tonle Sap (Great Lake) in the northwestern part of the country. The central plain is surrounded by hilly terrains along the borders. The country belongs to the monsoon climate. The average temperature of Phnom Penh, the capital of Cambodia, is 27.7°C. The rainy season, during which around 90% of annual precipitation occurs, runs from May to November, and the dry season lasts from December to April. The precipitation varies greatly depending on the region of the country, ranging from 1,200 mm/year in the northwestern region to over 4,000mm/year in the southwestern region. The average precipitation of the whole country is approximately 2,000mm/year.

Rattanakiri Province, where the Project Site is situated, is located in the hilly areas of the northeastern region bordering Vietnam and Laos. The province has an area of 10,782 km^2 annual precipitation of 2,154 mm, and the highest and lowest temperatures of 32.3°C and 22.7°C.

2.2.3 Environmental and Social Consideration

2.2.3.1 Evaluation of Environmental and Social Impact

2.2.3.1.1 Outline of Project Components Causing Environmental and Social Impacts

As explained in 1.1, the components of this project are as follows;

1) Construction of small power station at the O'Chum No.1 dam.
2) Re-construction of existing facilities including an intake at the O'Chum No.1 dam
3) Construction of distribution line from the new hydro power plant of O'Chum No.1 Power Station
4) Replacement of facilities including generators in the O'Chum No2. Power Station
5) Rehabilitation of the road for maintenance in the O'Chum No2. Power Station

Thus, the project does not include development of new reservoir, nor large-scale civil engineering work. Although significant negative impacts would hardly occur through the project, it was identified that two families were affected by the project at the candidate site of construction of the O'Chum No.1 Power Station.

Table 2.2.3.1.1-1 Project Components and Environmental & Social Impacts Expected

	Project components	Impacts expected	
		Environmental	Social
1	Construction of O'Chum No.1 Power Station : Approximate capacity of 265 kW : 8,500 m^2 of area for construction of power plant including power house, penstock, road, and etc.	Impact on landscape of water fall near the construction site	Resettlement of villagers who do farming near the candidate site. (Farmers who do farming on EDC's land should quit the farming and leave from the land.)
2	Re-construction of existing facilities at O'Chum No.1 dam : Intake, canal	No impacts expected	【after construction】 Land utilization by community members in/around the reservoir affected by rising of water level during dry season.
3	Construction of 22 kVdistribution line : Approximate 730 m of length of line. : route running on EDC's land and along existing road.	No impacts expected	No impacts expected (concern by community members about tombs near distribution line)
4	Replacement of facilities in the O'Chum No2. Power Station : generators of which approximate capacity is 960kW	No impacts expected	No impacts expected
5	Rehabilitation of administrative road (380 m in length and 5 m in width) at the O'Chum No2. Power Station	No impacts expected	No impacts expected

2.2.3.1.2 Environmental and Social Status as Baseline

Population and socio-economic status are described at 1.1.3.

According to the "Provincial Databook Rattanakiri 2008", the total population of Rattanakiri Province is 146,186 which includes 94,242 of the highland ethnic minorities. They are classified into 16 groups such as Tompuonn (35,959), Charay (23,454), Kroeung (18,696[10]).

There are three villages around the project area, namely O'Chum, Tharang Chong and Tharang Svay. Total population in these villages is 1,671 which consists mainly of the highland ethnic minorities. The majority group is Kroeung of which population is 1,401 (83.4%[11]). Based on the information collected through hearing with community members, EDC staff and Department of culture and fine art, the definition of "indigenous people" used by World Bank and actual status of community members around the project area are summarized in Table 2.2.3.1.2-1

Table 2.2.3.1.2-1 Definition of "Indigenous Peoples" by World Bank and actual Status of Communities

	Definition by WB	Status of communities
1	Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others	• They distinguish themselves from other groups by languages they speak • According to Khmer EDC staff, he is not able to distinguish Kroeung people with others in appearance. • To express its identity through putting on ethnic costume in daily life, is observed in the northern mountainous area in Ratanakiri Province, but not in project area.(by Director of Department of Culture and Fine Art) • House with ethnic style introduced in tourist office is not observed in the communities around the project area.
2	Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories	• According to the interview with village chief and community members, they often leave their village as seasonal worker. Strong collective attachment to their habitats is not clearly observed • In a similar way, dependent to and/or claim on utilization of natural resources are not identified • There is no community which has the common to forest in O'Chum district (by O'Chum District Governor)
3	Customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture	• They organize their own festival which differ from that of Khmer, however, the villagers in three village are not so active than other villages. • Most of the community members are farmers who are fully involved with market economy through sales of their products such as casher nuts. There are people who get day-labour job in lubber plantation and/or work away from home. • While they take part in national election in Cambodia, any cases that they select their ethnic leaders by themselves are not identified. • Some get married with Khmer.
4	An indigenous language, often different from the official language of the country or region	• Kroeung people and Tompuonn people speak their own languages in three villages around the project area.

[10] It is 17 groups in total when "other group" is included. Apart from these groups, Lao, Vietnamese and Khmer Isramic are categorized.

[11] Commune Database 2008

According to World Bank, the term “Indigenous Peoples” is used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the four characteristics above in varying degrees.

Community members around the project site have their own languages by which they can distinguish themselves with other ethnic groups. On the other hand, the collective attachment to their habitats and the natural resources in the habitats, and the customary cultural, economic, social, and political institutions that are separate from those of Khmer society and culture are not clearly identified.

Three villages concerned are located in the center of O’Chum district, 5 km away from Banlung city to which can be access through national road. It is concluded that they still keep their own social and cultural characteristics as ethnic minority, and are in assimilation into Khmer.

2.2.3.1.3 Legal and Organizational Framework of Environmental and Social Consideration

(1) Procedure of Environmental Impact Assessment in Cambodia

Two regulations on EIA in Cambodia are identified. They are,

: No.72 ANRK.BK.Sub-Decree on Environmental Impact Assessment Process, 1999

: Declaration on Guideline for Conducting Environmental Impact Assessment Report, 2000

EIA in Cambodia is categorized into two. The one is an Initial Environmental Impact Assessment, called as IEIA, which is similar to IEE of JICA. The other is a Detailed Environmental Impact Assessment, called as EIA or Detailed EIA. The Sub-Decree above describes contents and format of EIA as well as criteria of project/business which need to conduct detailed EIA. As for hydropower, a project of which capacity of generation is more than 1MW is required for detailed EIA.

For a hydro power project of which capacity is less than 1MW, like this project in Rattanakiri, the regulations above do not clearly stipulate if IEIA should be required or not.

Staff in EDC and those in MOE shown defferent understandings regarding this issue, in short, some said it’s required and the other said no need. Finally, the director of the department of EIA review clearly remarked, EDC-JICA project in Rattanakiri doesn’t need detailed EIA nor IEIA, in respence to the question from EDC.

According to the Declaration, a provincial department of environment reviews the IEIA report with related authorities. In case that there is no inadequacy found in the report, a result of the review will be announced within 30 days. The project is allowed to proceed when few possibilities is identified to cause serious negative impacts in environmental and social aspects. Otherwise, more detail information and detailed EIA report are required to be submitted to Department of EIA review, Ministry of Environment. As similar to IEIA, EIA report is reviewed and a result come out within 30 days, and the project will be allowed to proceed, when appropriate measures against negative impacts are planned in the project components.

(2) Ministry of Environment

The Ministry of Environment plays an important role in facilitating and carrying out the development of policies, environmental planning that are necessary for sustainable development in coordination with inter-ministries, international organizations, non-government organizations, and private and public sectors.

There are three general directorates under minister, namely "General Directorate of Administration and Financial", "General Technical Directorate" and "General Inspection Directorate". Under General Technical Directorate, seven department, namely " Planning and Legal Affair", "Natural Conservation and Protection", "Environmental Pollution and Control", "Environmental Education and Communication", EIA review", "International relation" and "Natural Resource Management and Environmental Data Management". There are also department of Environment in each province. Figure 2.2.3.1.3-1 shows organization chart of Ministry of Environment.

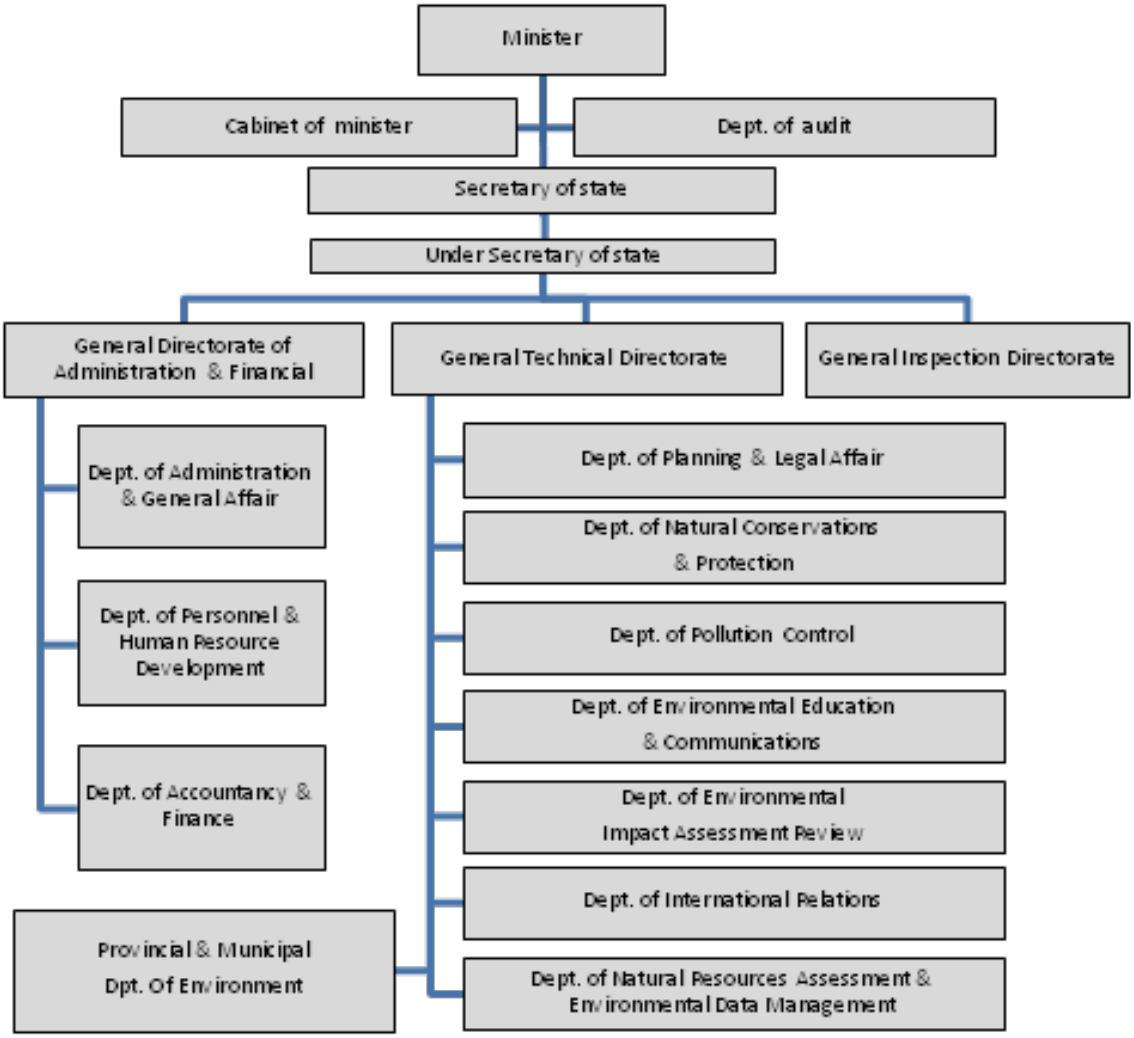


Figure 2.2.3.1.3-1 Organizational Chart of MOE

2.2.3.1.4 Comparison of Alternatives

Before the site survey conducted in August 2012, the study team analyzed and compared four options which differ in the locations of construction site for new power station. Considering the initial request from Cambodian government, technical aspects including possible capacity of generation, impacts on environmental and social matters, the study team selected the option in which power station is constructed at approximately 250 m downstream of O'Chum No.1 dam (Table 2.2.3.1.4-1(i)).

Table 2.2.3.1.4 -1 Comparisonof Alternatives

Possible Options	Capacity	Analysis	Socio-Environmental Impact
(i) Construct power station at just down stream of No.1 dam	265kW	• utilize EDC's land • No impact on down stream • Relatively small scale civil engineering work.	Small
(ii) Utilize a water head at O'Chum No.1 dam and that between No1.dam and No.2 dams. (Introduce pressure tunnel and construct power station between No1. & No.2 dams)	400kW	• need land expropriation • reduce water flow to waterfall • Large scale of civil engineering work, and take longer time for study	Large
(iii) Utilize a water head at O'Chum No.1 dam and that between No1.dam and No.2 dams. (Introduce a non-pressure tunnel and construct power station between No1. & No.2 dams)	400kW	• need land expropriation • reduce water flow to waterfall • Large scale of civil engeering work, and take longer time for study	Large
(iv) Utilize a water head down stream of O'Chum No.2 dam. (constract power station down stream of No.2 dam)	350~500kW	• need land expropriation • no impact on waterfall • Large scale of civil engineering work, and take longer time for study	Medium
(v) No project		• power supply condition remain to be unstable • EDC have to pay for import electricity	—

2.2.3.1.5 Scoping and TOR of Environmental and Social Consideration

The result of scoping, TOR and/or method of survey of Environmental and Social Consideration for the items listed in the check for "Hydropower , Dam, Reservoir" and "Power Transmission, Distribution" in JICA Environmental and Social Guideline 2010 JICA, are summarized in Table 2.2.3.1.5-1 to 2.2.3.1.5-4 below.

The followings are meanings of the scores for evaluation results.

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

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

C+/-: Extent of positive/negative impact is unknown.
(A further examination needed, and the impact could be clarified as the study progresses)

D : No impact is expected.

Table 2.2.3.1.5-1 Scoping and TOR of Environmental and Social Consideration (1)
– Pollution Control –

Category	Items to be checked	Results		Reasons Method /TOR remarks
		During construction	After construction	
(1) Water Quality	【Hydropower • Transmission line】			
	(a) Impact caused by civil engineering works.	C	-	Scale of civil engineering work is expected to be small, and any impact on water quality is not foreseen. . Field survey will be conducted for confirmation
	【Hydropower】			
	(a) Water quality in reservoir, & Quality standard * a possibility that proliferation of phytoplankton and zooplankton	C	C	It is not expected that water quality will be affected since the project aims a renovation of the existing dam. A possibility of proliferation of planktons will be estimated by examination of volume of water flow and reserved water.
	(b) Quality of water discharged	D	D	A civil engineering work during construction may cause muddy water, which, however, is not expected to reach quality standard.
	(c) Woody vegetation in the reservoir	D	D	Woody vegetation in the reservoir was already cleared by the prior project.
	(d) Water quality degradation in downstream area caused by the reduced river flow	C	D	The civil engineering work that may affect water flow is planned to be conducted in dry season, then, it would not be expected to cause deterioration of water quality. A volume of water flow in dry season, particularly a period of civil work, will be surveyed with existing statistics.
	(e) Water discharged from the lower portion of the dam reservoir (the water temperature of the lower portion)	C	C	To be analyzed and judged by site survey.
	【Transmission line】			
	(f) Degradation of water quality degradation caused by soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling water areas?	D	D	The project install distribution lines but not build transmission tower. The line root will be along the existing street, therefore, no negative impacts happen to river..

Category	Items to be checked	Results		Reasons Method /TOR remarks
		During construction	After construction	
(2) Air	【Hydropower • Transmission line】			
	(a) Impact caused by civil engineering works.	C-	-	Scale of civil engineering work is expected to be small, and any impact on water quality is not foreseen. . Field survey will be conducted for confirmation
(3) Wastes	【Hydropower】			
	(a) Treatment of earth and sand generated by excavation	C	C	To be evaluated by estimating a volume of earth and sand by site survey
	(b) Pole transformer which contain PCB	D	D	The project does not replace any existing pole transformers.

Table 2.2.3.1.5-2 Scoping and TOR of Environmental and Social Consideration (2)

– Natural Environment –

Category	Items to be checked	Results		Reasons Method /TOR remarks
		During construction	After construction	
(1) Protected Area	【Hydropower • Transmission line】			
	(a) Location of protected area, Impacts on protected area	D	D	A protect area does not locate in/near to project area. There are two natural reserves protected by law in Ratanakiri province. They are Virachay National Park, and Lomphat Sanctuary both of which are far from project area by more than 35 km with direct distance.
(2) Eco- system	【Hydropower・Transmission line】			
	(a) ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)	D	D	There are not such places.
	(b) protected habitats of endangered species	C	C	Hearing form Department of Environment and/or community members.
	【Hydropower】			
	(c) Adversely impacts to downstream aquatic organisms, animals, plants, and ecosystems	C	D	To be evaluated through analysis of a volume of water (to confirm existing statistics during site survey)
	(d) Impacts on migratory fish species	D	D	There is no migratory fish species found in the project area.

Category	Items to be checked	Results		Reasons Method /TOR remarks
		During construction	After construction	
(2) Eco- system	【Transmission line】			
	(e) Significant ecological impacts on the ecosystem	D	D	No significant impacts are anticipated The project does not include a large-scale civil engineering work such as construction of transmission towers The line will be installed along the existing road.
	(f) Disruption of migration routes and habitat fragmentation of wildlife and livestock	D	D	The project components do not include distribution line and/or construction work which disrupt migration routes of wildlife and livestock
	(g) Destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem	D	D	The project area does not include natural forest nor wetland areas. In addition, a scale of civil engineering work is relatively small.
	(h) Extensive loss of natural environments in undeveloped areas	D	D	It's not applicable to this project.（The project site locates in developed area）
(3) Hydro-Logy	【Hydropower】			
	(a) Hydrologic changes due to the installation of structures, such as weirs (especially in "run off the river generation" projects)	D	D	The project is not "run off the river" type. The project installs water pipe of which length is 250m, and so, a flow of surface water will change only around that area. However, it will not bring negative impacts due to its small –scale of the facility
(4) Topography and Geology	【Hydropower】			
	(a) Reductions in sediment loads at downstream area, Sedimentation of the reservoir	D	D	It's not applicable（the project components does not include construction of dam reservoir）。
	(b) A large-scale alteration of the topographic features and geologic structures in the surrounding areas	D	D	The physical scale of facilities in the project is small, and does not cause a large scale alteration of the topographic features. To make water intake higher location, the lowest water level in dry season become also higher. However, this does not means that maximum water level in the reservoir become higher nor bring a large scale alternation of the topographic features.
	【Transmission line】			
	(c) Slope failures or landslides	D	D	Distribution line does not run on the places where slope failures or landslides likely occur.
	(d) Civil engineering works, such as cutting and filling causing slope failures or landslides	D	D	The civil engineering work is relatively small, and could not bring slope failure nor land slope.
	(e) Soil runoff resulting from cut and fill areas, waste soil disposal sites, and borrow sites.	D	D	The project does not bring such runoff since the civil engineering work is relatively small.

Table 2.2.3.1.5-3 Scoping and TOR of Environmental and Social Consideration (3) – Social Environment –

Category	Items to be checked	Results: During construction	Results: After construction	Reasons / Method /TOR / remarks
(1) Resettlement	【Hydropower • Transmission line】			
	(a) Involuntary Resettlement	C-	C	It is expected that involuntary resettlement will not occur, since the construction site of power plant will locate on EDC's land. Distribution line will be installed along the existing road. To be confirmed by site survey.
(2) Living and Livelihood	【Hydropower • Transmission line】			
	(a) Adversely impacts on the living conditions of inhabitants	C-	D	A power plant will be constructed on the land of EDC, and distribution lines are laid along existing roads. The size of facilities is relatively small. Therefore, the project does not cause adversely impacts on living and livelihood of community members. However, during construction phase, there is a possibility for the project to cause negative impacts on community. Actual status and area of community life will be confirmed by the field survey.
	(b) Diseases due to immigration of workers associated with the project	D	D	Operation and maintenance of the project facilities do not cause immigration. For construction work, most of workers except skilled ones could be employed from communities in/around the project site.
	【Hydropower】			
	(c) Change of land uses in the neighboring areas, adversely affecting livelihood of local people	C-	C-	Actual status of land uses around the project site; O'Chum No1& No2 dams and distribution line are surveyed through field observation and hearing from community member
	(d) Negative impacts on traffic systems	C-	D	There is no water traffic. No negative impacts caused by the project facilities are expected for traffic system Impacts by vehicles for civil work during the construction period will be estimated through the site survey.
	(e) The minimum flow required for maintaining downstream water uses	C-	D	A volume of water flow does not change before/after the construction of the project facilities. Due to a civil engineering work during construction period, water does not flow from O Chum No1 dam. The minimum requirement of water flow will be confirmed by hearing from community members and by examination of the existing statistics data

Category	Items to be checked	Results		Reasons Method /TOR remarks
		During construction	After construction	
(2) Living and Livelihood	(f) Reductions in water flow affecting water use and land uses in downstream area	C^-	D	Actual status of water uses and land uses are surveyed After the construction of the project facilities, volume of water flow will not change.
	(g) Water-borne or water-related diseases	D	D	Few possibilities are identified since the project components do not include construction of reservoir.
	(h) Fishery rights, water usage rights, and common usage rights	$C^{+/-}$	D	A status will be surveyed through hearing from community members.
	【Transmission line】			
	(i) Radio interference	D	D	Distribution line by the project does not cause radio interference because of its low voltage capacity.
	(j) A compensations for transmission wires given in accordance with the domestic law	D	D	The project will install low voltage distribution line. Under the current regulations. EDC does not have legal obligation to pay compensation for ROW of distribution line.
(3) Heritage	【Hydropower • Transmission line】			
	(a) Negative impacts on the local archeological, historical, cultural, and religious heritage	D	D	No heritage is identified in/around the project site.
(4) Landscape	【Hydropower • Transmission line】			
	(a) Negative impacts on Landscape	B^-	B^-	There is small water fall in downstream area of O8Chum No1.dam. The construction site will be selected from four options in order to minimize negative impacts on this water fall. To what extent will it affect is examined through the field survey.
(5) Ethnic Minorities and Indigenous Peoples	【Hydropower • Transmission line】			
	(a) Minimization of negative impacts on the culture and life style of ethnic minorities and indigenous peoples	$C^{+/-}$	$C^{+/-}$	Approximately 90 % of people in Ratanakiri province is ethnic minority. Actual status of ethnic minorities and indigenous peoples are surveyed and considered through site survey and hearing form community members.
	(b) Respect on all of the rights of ethnic minorities and indigenous peoples in relation to land and resources	$C^{+/-}$	$C^{+/-}$	Same as above

Category	Items to be checked	Results		Reasons Method /TOR remarks
		During construction	After construction	
(6) Working conditions	【Hydropower • Transmission line】			
	(a) laws and ordinances associated with the working conditions	D	D	To comply with related laws such as labour Law (1997)
	(b) tangible safety considerations for working conditions	B^-	—	The followings are considered. -to always put helmet, - and put safety belt, safety boots and dust mask if necessary -to enclose dangerous area by fence, and put board for attention.
	(c) Intangible measures for working conditions	B^-	—	The followings are considered. -to establish emergency system with a local medical facility -to provide safety education to all workers -to confirm the procedure of the work, and instruct safety practice in daily meeting
	(d) Appropriate measures taken to ensure that security guards involved in the project not to violate safety of stakeholders	D	D	There is no serious issue on safety found in the project area. Community members do not look to be against the project. Security guard will be hired from communities, or security of the construction site is managed with cooperation of communities.
	(e) Land mine, UXO	C^-	C^-	Hearing from community members to confirm current status of land mines and UXOs

Table 2.2.3.1.5-4 Scoping and TOR of Environmental and Social Consideration (4)

– Others –

Category	Items to be checked	Results		Reasons Method /TOR remarks
		During construction	After construction	
(1) Impacts during Construction	【Hydropower • Transmission line】			
	(a) impacts by noise, vibrations, turbid water, dust, exhaust gases, and wastes	C-	—	It is not foreseen that the project causes such negative impact. To evaluate it when a detail of project components is determined.
(2) Accident Prevention Measures	【Hydropower】			
	(a) warning system to alert the inhabitants to water discharge from the dam	D	C-	Warning system is not necessary so much, because a designed discharged volume form spill way does not change after the construction of the project facilities. To be confirmed according the results of field survey.
(3) Monitoring	【Hydropower • Transmission line】			
	(a) Planning & implementation of monitoring program	C-	C-	At this moment, no item causing negative impacts on environment is found. The study team will discuss this matter with EDC. Necessity of a visual monitoring on river water during a construction period is considered
	(b) Items, methods and frequencies of the monitoring program?	C-	C-	If necessary, to be determined
	(c) Monitoring organization, personnel	C-	C-	Environmental monitoring is considered only during construction period. When generator is running, EDC will monitor as a part of regular operation. A detail will be considered through the field survey.
	(d) Report of monitoring	C-	C-	A reporting isn't required since the project does not adversely affect on environment. To be considered based on the results of the field survey.
Others	【Hydropower・Transmission line】			
	(a) Impacts to global issues	D	B+	The electricity generated by the project will replace those imported from Vietnam. It can be assumed that emission of CO2 is reduced for this portion.

2.2.3.1.6 Results of Survey and Evaluation on Environmental Social Consideration

The results of field survey and evaluation are summarized in from Table 2.2.3.1.6-1 to Table 2.2.3.1.6-4. The meaning of scores, "A^+/-", "B^+/-", "C^+/-"and "D" are as same as those explained in section 2.2.3.1.5.

The meanings of the other scores are as follows;

"N/A": Not applicable

" - ": item excluded from evaluation

Table 2.2.3.1.6-1 Results of field survey and evaluation (1) －Pollution Control－

Category	Items to be checked	Evaluation at scoping		Final evaluation		Results of the survey Reasons for evaluation
		During construction	After construction	During construction	After construction	
(1) Water Quality	【Hydropower・Transmission line】					
	(a) Impact caused by civil engineering works.	C	-	D	-	Proportion of civil engineering work is small (approximately 20 % of total costs). Aggregate plant is for concrete is not necessary, therefore, no negative impact such as turbid water will not occur.
	【Hydropower】					
(1) Water Quality	(a) Water quality in reservoir, & Quality standard * a possibility that proliferation of phytoplankton and zooplankton	C^-	C^-	D	D	As for planktons concerned, a proliferation will hardly occur due to the following reasons. Upgrading of an intake of O Chum No.1 dam makes the lowest water level for discharging higher, which causes an increase of dead storage water. The amount of the water is approximately 6.50 million cubic meters, while the total amount of inflow water to the reservoir is 34.4 million cubic meters. This means the dead storage water could be replaced 5 times a year. It is generally considered that proliferation of plankton does not happen when water stock is replaced more than twice a year. In addition, upstream of the reservoir is a depopulated area. Therefore, it may discharge less human sewage that may cause eutrophication leading proliferation of planktons.
	(b) Quality of water discharged	D	D	N/A	N/A	(See Table 2.2.3.1.5-1)
	(c) Woody vegetation in the reservoir	D	D	N/A	N/A	(See Table 2.2.3.1.5-1)
	(d) Water quality degradation in downstream area caused by the reduced river flow	C	D	D	D	In the region, rainy season and dry season are clearly divided. Water is dried up during dry season. The civil work that may affect water flow is planned to be conducted in dry season, then, it would not be expected to cause deterioration of water quality.
	(e) Water discharged from the lower portion of the dam reservoir (the water temperature of the lower portion)	C	C	D	D	Water depth in the reservoir is 14.5 meters, only of which 4.5 meters from surface of water level will be used for generation. New water intake locates at 4.5 m higher from existing facilities. Therefore, water temperature will not become lower than now
	【Transmission line】					
	(f) Degradation of water quality degradation caused by soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling water areas?	D	D	N/A	N/A	(See Table 2.2.3.1.5-1)

Category	Items to be checked	Evaluation at scoping		Final evaluation		Results of the survey Reasons for evaluation
		During construction	After construction	During construction	After construction	
(2) Air	【Hydropower・Transmission line】					
	(a) Impact caused by civil engineering works	C		D		Proportion of civil engineering work is small (approximately 20 % of total costs). Aggregate plant is for concrete is not necessary, therefore, no negative impact on air will not occur.
(3) Waste	【Hydropower・Transmission line】	C^-	C^-	D	D	The largest civil engineering work could be construction of temporary dike in the current reservoir in order to keep water from leaching an intake tower during its upgrading work. Soil in the reservoir (near spillway) will be used to build the dike. The dike will be removed, and the soil will be filled back to lower area within the reservoir after the upgrading work is completed. Therefore, soil erosion to downstream of the dam would hardly happen.
	(b) Pole transformer which contain PCB	D	D	N/A	N/A	(See Table 2.2.3.1.5-1)

Table 2.2.3.1.6-2 Results of field survey and evaluation (2) －Natural Environment－

Category	Items to be checked	Evaluation at scoping		Final evaluation		Results of the survey Reasons for evaluation
		During construction	After construction	During construction	After construction	
(1) Protected Area	【Hydropower・Transmission line】					
	(a) Location of protected area, Impacts on protected area	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
(2) Eco-system	【Hydropower・Transmission line】					
	(a) ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	(b) protected habitats of endangered species	C-	C-	D	D	The project does not encompass such habitat.
	【Hydropower】					
	(c) Adversely impacts to downstream aquatic organisms, animals, plants, and ecosystems	C-	D	D	D	In the region, rainy season and dry season are clearly divided. Water is dried up during dry season. The civil work that may affect water flow is planned to be conducted in dry season, then, it would not be expected to cause negative impacts on ecosystems.
	(d) Impacts on migratory fish species	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	【Transmission line】					
	(e) Significant ecological impacts on the ecosystem	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	(f) Disruption of migration routes and habitat fragmentation of wildlife and livestock?	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	(g) Destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	(h) Extensive loss of natural environments in undeveloped areas?	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
(3) Hydrology	【Hydropower】					
	(a) Hydrologic changes due to the installation of structures, such as weirs (especially in "run off the river generation" projects)	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)

Category	Items to be checked	Evaluation at scoping		Final evaluation		Results of the survey Reasons for evaluation
		During construction	After construction	During construction	After construction	
(4) Topography and Geology	【Hydropower】					
	(a) Reductions in sediment loads at downstream area, Sedimentation of the reservoir	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	(b) A large-scale alteration of the topographic features and geologic structures in the surrounding areas	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	【Transmission line】					
	(c) Slope failures or landslides	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	(d) Civil works, such as cutting and filling causing slope failures or landslides	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)
	(e) Soil runoff resulting from cut and fill areas, waste soil disposal sites, and borrow sites.	D	D	N/A	N/A	(See Table 2.2.3.1.5-2)

Table 2.2.3.1.6-3 Results of field survey and evaluation (3) －Social Environment－

Category	Items to be checked	Evaluation at scoping		Final evaluation		Results of the survey Reasons for evaluation
		During construction	After construction	During construction	After construction	
(1) Resettlement	【Hydropower・Transmission line】					
	(a) Involuntary Resettlement	C-	C-	B-	B-	It is identified that two families plants cashew nuts trees near candidate site for construction of power plant on EDC's land.
(2) Life/Lively-hood	【Hydropower・Transmission line】					
	(a) Adversely impacts on the living conditions of inhabitants	C-	D	D	D	(See Table 2.2.3.1.5-3) According to the site survey, the access road and distribution line will be constructed at far from villages. Therefore, no negative impacts caused by vehicles for construction work is anticipated
	(b) Diseases due to immigration of workers associated with the project	D	D	N/A	N/A	(See Table 2.2.3.1.5-3)
	【Hydropower】					
	(c) Change of land uses in the neighboring areas, adversely affecting livelihood of local people	C	C	C	C	Water level in O'Chun No1 dam reservoir goes up in dry season due to improvement of facilities. It was reported that someone plant vegetable at the places which appear in the reservoir only in dry season. The study team could not confirm that, therefore, EDC was asked to conduct follow-up survey. It is necessary for JICA to support EDC in case there is someone affected by the project.
	(d) Negative impacts on traffic systems	C-	D	D	D	(See Table 2.2.3.1.5-3) In observation, there was not so much traffic around the project area. Therefore the project will not bring negative impacts on the traffic.
	(e) The minimum flow required for maintaining downstream water uses	C-	D	B－	D	According to the interview, water flow becomes small in dray season, but not dried up. A pipe to discharge water to downstream area should be installed in construction period.
	(f) Reductions in water flow affecting water use and land uses in downstream area	C-	D	B－	D	It is identified that water is used for washing, and rarely drinking when ceremony. To install pipe to discharge water should be planned After starting of operation of new hydro power plantation, water flow between O'Chum No1 and No2 becomes stable through year.
	(g) Water-borne or water-related diseases	D	D	N/A	N/A	(See Table 2.2.3.1.5-3)

Category	Items to be checked	Evaluation at scoping		Final evaluation		Results of the survey Reasons for evaluation
		During construction	After construction	During construction	After construction	
(2) Life/Lively-hood	(h) Fishery rights, water usage rights, and common usage rights	C^-	D	D	B^+	In O'Chum dam No1 reservoir, community members release fish and manage it. The area for civil work in the reservoir is estimated to be 16,000 m2 at maximum, which account for less than 1 % of total area of the reservoir. Therefore, no negative impact on fish will be anticipated. It is recommended that fish should be released after construction if community member show their concern about this issue. Due to improvement of facilities, water level in the reservoir goes up which may make better condition for fish to grows.
	【Transmission line】					
	(i) Radio interference	D	D	N/A	N/A	(See Table 2.2.3.1.5-3)
	(j) A compensations for transmission wires given in accordance with the domestic law	D	D	N/A	N/A	(See Table 2.2.3.1.5-3)
(3) Heritage	【Hydropower • Transmission line】					
	(a) Negative impacts on the local archeological, historical, cultural, and religious heritage?	D	D	N/A	N/A	(See Table 2.2.3.1.5-3)
(4) Landscape	【Hydropower • Transmission line】					
	(a) Negative impacts on Landscape	B^-	B	B	B	To minimize negative impacts on landscape, the generator house will be built at the place so that it is not directly seen from the downstream of the water fall. Also, trees around the generator house will not logged as much as possible.
(5) Ethnic minority	【Hydropower • Transmission line】					
	(a) Minimization of negative impacts on the culture and life style of ethnic minorities and indigenous peoples	$C^{+/-}$	$C^{+/-}$	D	D	There are three villages around the project site where ethnic minorities; Kroeung,Tompuon and Prav are lining. It is observed that they still keep their own social and cultural characteristics as ethnic minority, and are now in assimilation into Khmer. The project components such as construction of power plant and transmission line will not adversely affect their culture and life style. (Also see section 2.2.3.2)
	(b) Respect on all of the rights of ethnic minorities and indigenous peoples in relation to land and resources	$C^{+/-}$	$C^{+/-}$	D	D	According to the interview with village leaders, they understand that the land for construction of project facilities belong to EDC which does not include places where they take natural resources.

Category	Items to be checked	Evaluation at scoping		Final evaluation		Results of the survey Reasons for evaluation
		During construction	After construction	During construction	After construction	
(6) Working conditions	【Hydropower • Transmission line】					
	(a) laws and ordinances associated with the working conditions	D	D	N/A	N/A	(See Table 2.2.3.1.5-3)
	(c) Tangible safety considerations for working conditions	D	—	N/A	N/A	(See Table 2.2.3.1.5-3)
	(d) Intangible measures for working conditions	D	—	N/A	N/A	(See Table 2.2.3.1.5-3)
	(e) Appropriate measures taken to ensure that security guards involved in the project not to violate safety of stakeholders	D	D	N/A	N/A	(See Table 2.2.3.1.5-3)
	(f) Land mine, UXO	C^-	C^-	D	D	According to the interview with community members, Any cases of landmine and UXO are not reported around the project site 【Additional Consideration】 Sign boards which alert landmine and UXO are found along streets around Banglung city. Careful attention should be paid during construction period

Table 2.2.3.1.6-4 Results of field survey and evaluation (4) －Others－

Category	Items to be checked	Evaluation at scoping		Final evaluation		Results of the survey Reasons for evaluation
		During construction	After construction	During construction	After construction	
(1) Impacts during Construction	【Hydropower・Transmission line】					
	(a) impacts by noise, vibrations, turbid water, dust, exhaust gases, and wastes	C-	－	D	—	The civil work doesn't require blasting operation, nor concrete aggregate plant. Therefore, any negative impact by noise, vibration, turbid water will not be anticipated. Residential area is far by 300m from the construction site, so noise from heavy machinery will not affect them.
(2) Accident Prevention Measures	【Hydropower】					
	(a) warning system to alert the inhabitants to water discharge from the dam	D	C-	D	N/A	No warning system required because of small volume of water discharged. (Planed water discharge is 2-3 m^3/sec. which is as same level as now. Pls, water discharge from spill way is 4.5 m^3/s)
(3) Monitoring	【Hydropower・Transmission line】					
	(a) Planning & implementation of monitoring program	C-	C-	B-	B-	Through overall consideration. Monitoring on environment is not required. Only monitoring for resettlement (＊income status of farmers who left from EDC's land) should be planed and conducted.
	(b) Items, methods and frequencies of the monitoring program	C-	C-	B-	B-	(See 2.2.3.2 "Resettlement")
	(c) Monitoring organization, personnel	C	C	D	D	(See 2.2.3.2 "Resettlement")
	(d) Report of monitoring	C	C	D	D	No need to report since no monitoring activity will be conducted.
Others	【Hydropower・Transmission line】					
	(a) Global issue	D	B+	D	B+	The electricity generated by the project will replace those imported from Vietnam. It can be assumed that emission of CO2 is reduced for this portion.

2.2.3.1.7 Mitigation Measures and Cost Estimated

For the items categorized as "B-", "C" and those needs additional consideration descried in 2.2.3.1.6, appropriate mitigation measures should be prepared. The items, the measures and its estimated costs are summarized in Table 2.2.3.1.7-1.

Table 2.2.3.1.7-1 Mitigation Measures, Implementation/Responsible Party and Estimated cost

Items	Mitigation Measures/Countermeasures	Implementation/ Responsible party	Estimated cost
Involuntary Resettlement (B^-)	EDC has paid 1,000USD as compensation to two families concerned. They have already moved out from the land. For one family who has lost its main income source, additional measures including an employment as worker by EDC are under consideration.	EDC	1000USD (When EDC employs the person, at least 300USD per year should be paid.)
Change of land uses in the neighboring areas, (C^-)	This coming dry season, to confirm if there are someone using a land in the O'Chum No.1 reservoir. Then, to take countermeasures if necessary	EDC	Unknown
The minimum flow required for maintaining downstream water uses (B^-)	During the civil work in O'Chum No1 reservoir, to install pipe to discharge water (100 liters/min.) to downstream area	Constructor	No additional cost (included in grant aid)
Reductions in water flow affecting water use and land uses in downstream area (B^-)	Same as above	Constructor	No additional cost (included in grant aid)
Water quality degradation in downstream area caused by the reduced river flow(C^-)	Same as above	Constructor	
Fishery right (additional consideration)	Although the civil work by the project will not affect adversely fishes in the reservoir, it is recommended that fish should be released into the reservoir after construction if community member show their concern about this issue.	Under consideration	—
Landscape of waterfall (B^-)	Generator house will be built at the place so that it is not directly seen from the downstream of water fall. Also, trees around the generator house will not be logged.	Constructor	No additional cost (included in grant aid)
Land mine & UXO (additional consideration)	For confirmation, before the civil work, to remind workers to pay attention.	Constructor	—

2.2.3.1.8 Monitoring Plan

A constructor should conduct monitoring for mitigation measures and/or countermeasures for water utilization at down stream of O'Chum No.1 dam and negative impacts on river water. It is expected that discharge water should be kept to flow during construction work, and also it should be observed

that turbid water will not occur so as to be used in the down stream. Table 2.2.3.8.1-1 summarize monitoring format (draft).

Table 2.2.3.1.8-1 Monitoring Form (draft)

Date	Water discharge (by observation) <litre/s>	Turbidity of water discharge (Turbidity; High, Middle, Post)	Remark
Nov.1.2013			
Nov.2 2013			
・ ・ ・ ・			
Nov. 2013/1			

Monitorng items for resettlement will be summarized in Table 2.2.3.2.6

2.2.3.1.9 Stakeholder Meeting

During the field survey period in August 2012, the study team visited stakeholders in the communities around the project site. The team explained the outline of the project and obtained comments and/or request from them. They are summarized in Table 2.2.3.1.9-1.

Table 2.2.3.1.9-1 Stakeholder meeting held in August 2012

	Date	Stakeholder	Comments related to Items for Environmental & Social Consideration
1	Aug.2 2012	District Governor O'Chum district	• Community members and tourists visit the water fall • There is community fishery committee. They have rele ased fish into O'Chum No.1 reservoir and manage it.
2	Aug.3 2012	Vice village Chief, Village member, Tharang Chong	• Community members use water from O'Chum No.1 re servoir for washing and etc. • There are cemeteries in/around the villages
3	Aug.4 2012	Village Chief Tharang Svay Commune chief O'Chum commune	• It is recognized that the upstream land near water fall belongs to EDC. • Tombs are scattered in/around the villages. They are s acred places to community members, so it is requested that the project should not destroy them by the civil work. • Cashew nut trees are economically important to comm unity member. So, it is requested that the project sho uld try to avoid cutting them.

On December 14, 2012, another stakeholder meeting was organized at O'Chum district meeting hall. The representatives of community from O'Chum commune, O'Chum village, Tharang Chong, Tharang Svay, and the representatives from local authorities including O'Chum district office, Department of Environment Rattanakiri took part in the meeting. The study team and EDC explained more detail of the project and get comments on the project from the participants, which brought better understandings among the stakeholders.

2.2.3.2 Resettlement

2.2.3.2.1 Necessity of land Expropriation and Resettlement

Resettlement of people is required at the candidate site for construction of O'Chum No1 Power Station. This place exists on EDC's land and locates 300 m downstream of the dam crest. People who are living near village do farming on this land of which area is approximately 3,800 m^2.

These people were identified after the study team had selected that candidate site from the four options which had been analyzed prior to that field survey. However, the study team and EDC did not reconsider the site selection. This is because, firstly, this land is initially belongs to EDC. Secondary, people in the community also recognized that EDC is the owner for the land. Besides, only two families are resettled and they agreed to move out from the land.

2.2.3.2.2 Legal Framework for Land Expropriation & Resettlement

In the modern society in Cambodia, there have been two ideas of a right for land. One is "Ownership" which means absolute and exclusive right for land. The other is "Possession" which means a right obtained through continuous use of that land. After suspension during 1975-1979, as legal institution has been gradually developed, these rights have been recognized. As for land expropriation and resettlement issues are now legally considered and handled according to the three fundamental laws, namely The Constitution (1993), Land law (2001), Law on Expropriation (2010), and regulations under these laws, such as sub-decrees, declarations, and circulars.

The Constitution clearly recovers private property for land, and also prescribes public property and expropriation for public work. Land law states that "Any beginning of occupation for possession shall be cease when this law come into effect", whereas it also states that "Any person who, for no less than five years has the right to request a definitive title of ownership[12]. Law on Expropriation explains expropriation from legal title holder by public project. It prescribes the principles of expropriation such as "prior and fair compensation" and its procedure. This law is not applied to a project for which Cambodian government and donor agency have agreement regarding resettlement. Therefore, Cambodian government flexibly manages this issue[13].

2.2.3.2.3 Scale of Land Expropriation and Resettlement

Two families were required to be moved out from the EDC's land which is the candidate site for construction of O'Chum No1 Power Station. Both of them are Kroeung people and farmers doing cashew nuts farming.

[12] While the Amended Land Law clearly states that " Any person who, for no less than five years prior to the promulgation of this law, enjoyed possession of immovable property has the right to request a definitive title of ownership", JICA Cambodia office explained to the study team that it is practiced in the same way even after the promulgation of the law. Civil Code also describes that "A person who possesses an immovable for a period of 10 years with the intention of ownership shall acquire ownership", which sets longer period of procession for ownership than that of the Amended Land Law.

[13] Refer to " Laws and Regulations for land expropriation and resettlement", by Project on Capacity Enhancement of Environmental and Social Considerations for Resettlement, JICA.

The properties of these families on EDC's land are as follows;

- 12 species of fruit tree including cashew nuts. Total number of the trees is approximately 80
- Three species of crop including upland rice and corn
- One hut for farming of which floor area is approximately 18 m^2
  (see Table 2.2.3.2.4-1 for detail information)

Almost all properties above belong to one family, and the other family maintains only some of upland rice. The results of income and family survey are summarized in Table 2.2.3.2.3-1 below.

Table2.2.3.2.3-1 Results of Income & Family Survey

Family ID No1	Family ID No2
【Family structure】 • Number of members living together is 13 • including six of school children and one blind aged lady. 【Cash income and livelihood 】 • The main cash income source is cashew nuts plantation on EDC's land, which makes annual income of 75-300USD • Work occasionally as daily worker in lubber plantation • Apart from the land on EDC's land, possess a paddy field which yields 1.5 tons per year 【Property in EDC's land and land utilization】 • Almost all of fruit trees, economic trees and crop planted, plus a hut • use the land since about 10 years ago	【Family structure】 •· Number of members living together is 6 • including one infant and one aged lady 【Cash income and livelihood】 • The main cash income source is cashew nuts plantation on EDC's land, which makes annual income of 525-750USD • Work occasionally as daily worker in lubber plantation • Apart from the land on EDC's land、possess field for upland rice which yields 0.6tons per year 【Property in EDC's land and land utilization】 • only some of upland rice planted • use the land since about 3 years ago

2.2.3.2.4 Measures for Compensation and Support, Cost and Budget Source

It was agreed among stakeholders that EDC paid 1000USD to two families, which was the same amount as two families had requested, and the two families moved out from EDC's land. The study team interviewed the two families, and confirmed the kinds and number of properties for compensation. Then, replacement cost is multiplied by the number of each item, and simulate total amount of compensation (see Table 2.2.3.2.4-1). The result of survey by ADB[14], and data presented by agricultural marketing office are applied to unit price of replacement cost for the items.

[14] The survey conducted in 2011 for updating the resettlement plan for the transmission project financed by ADB.

Table 2.2.3.2.4-1 The result of Provisional Estimation for Amount of Compensation

1	Trees	Number of trees	Unit price (USD)	Amount (USD)	Reference of unit price
1.1	Bamboo	4	28.00	112.0	ADB RC Survey 2011
1.2	Banana	10	2.00	20.0	ADB RC Survey 2011
1.3	Jackfruit	3	23.44	70.3	ADB RC Survey 2011
1.4	Custard apple	2	2.67	5.3	ADB RC Survey 2011
1.5	Soursop	3	4.80	14.4	ADB RC Survey 2011
1.6	Guava	4	4.50	18.0	ADB RC Survey 2011
1.7	Milk fruit	1	9.92	9.9	ADB RC Survey 2011
1.8	Lemon/Lime	1	18.75	18.8	ADB RC Survey 2011
1.9	Mango	1	45.00	45.0	ADB RC Survey 2011
1.10	Orange	2	6.00	12.0	ADB RC Survey 2011
1.11	Cashew	50	9.00	450.0	ADB RC Survey 2011
1.12	Pomelo	1	20.00	20.0	ADB RC Survey 2011
	sub total			795.73	
2	Crops	Annual harvest (kg)	Unit price (USD)	Amount (USD)	Reference of unit price
2.1	Rice	30	0.75	22.50	Agricultural marketing office
2.2	Corn	20	0.58	11.60	Field survey
2.3	Cassava	60	0.08	4.80	Agricultural marketing office
	sub total			38.90	
3	Structure	Floor area (m2)	Unit price (USD)	Amount (USD)	Reference of unit price
3.1	Hut(without wall)	18.60	4.50	83.70	ADB RC Survey 2011
	sub total			83.70	
4	Others			81.67	
	Grand Total		USD	1000.00	

According to the results of interview with the two families, one of them has lost cashew nuts trees which were its main income source. Furthermore, a large number of family members with many children in contrast to amount of rice harvested indicate that this family lives in poor condition. Therefore, the study team requested that EDC should consider additional measure to support this family. At this moment, to hire the family head by EDC Rattanakiri could be the most feasible way, which enables the family to get steady income instead of cashew nuts.

2.2.3.2.5 Grievance Redress Mechanism

A grievance redress mechanism in which complain from the families is initially consulted by commune chief and/or district governor, will be considered. EDC staff in charge of grievance redress will be appointed in EDC Rattanakiri instead of head office because only two families are concerned and staff in Rattanakiri is more familiar with the language of ethnic minority.

2.2.3.2.6 Implementation Structure and Schedule, and Monitoring by Implementation Agency

Resettlement has been already completed in September 2012.

For the family who lost its main income source will be employed by EDC as additional support. The

monitoring plan for this issue will be summarized in Table 2.2.3.6-1 below..

Table 2.2.3.2.6-1 Minitoring plan for a Family Employed by EDC

Item	Monitoring method	Frequency and period	Implementation agency
Cash income of the family	: by interview : amount of cash income by the family including that paid by EDC as salary.	: Quarterly monitored and summarized annually : until 3year ahead from completion of the project	: monitored by EDC Ratanakiri : confirmed by EDC head office

2.2.3.2.7 Meeting by Community Members

On September 22, 2012, stakeholder meeting was held at O'Chum commune office. The district governor, the deputy director of Department of Land Management, chief of commune, staff from EDC Rattanakiri and the representatives of two families took part in the meeting. As described in the previous sections, it was agreed by the participants that EDC paid 1000 USD to two families and they move out from EDC's land.

2.2.3.2.8 Land User in O'Chum No1 Reservoir

As of December 2012, JICA survey team has not been able to confirm if there are persons who plant vegetable and/or crops in the O'Chum reservoir in dry season. It is expected that EDC should take necessary measures for this issues. The followings are proposed procedure.

: Conduct field survey (January to March, 2013), in order to;
+ confirm if there are persons do farming in the reservoir. and if there are;
+ identify each persons' profile (name &village to live), and kind of vegetables/crops planted,
+ estimate their yields.

: Then, conduct family survey to get the following information;
+ socio-economic status of the families including total income, and land holding other than in the reservoir.

: Estimate amount of compensation based on market prices of the vegetables/crops, and results of socio-economic status surveyed

: Hold stakeholder meeting to make consensus on the followings
+ compensation should be paid to persons concerned
+ the persons should no longer do farming in the reservoir.

: Pay compensation to the persons concerned. (by the end of April 2013)

3. Basic Concept of the Project

3.1 Project Background and Circumstances

In the Kingdom of Cambodia, electric power demand such as peak demand and also energy had been increasing more than 20% annually from 2003 to 2008. On the other hand, electricity imported into Cambodia accounts for 61.5% of total electric energy, and 91% of electric energy generated in Cambodia is mostly supplied from independent power producers which are mainly small scale of diesel power plant. Consequently, cost for power generation in Cambodia is higher than neighboring countries. Moreover, electric power system in Cambodia also is not interconnected with whole country, which causes insufficient of electricity of both quality and quantity in rural area especially. Regarding electrification rate in Cambodia, urban area is 87% (2008), as against 13% (2008) in rural area.

The Royal Government of Cambodia formulated "National Strategic Development Plan 2009-2013" and set the following policies in the development plan;

i. Securement of electricity supply capability
ii. Realization of moderated electricity tariff
iii. Enhancement and capacity building of organizations related to electricity supply

Additionally, the Royal Government of Cambodia also laid down "Promotion and Strategy Plan for Rural Electrification" in 2011 and set the following targets;

i. 100% of village would be electrified including battery illumination by 2020
ii. 70% of household would be electrified supplied from power grid by 2030

Rattanakiri province which is located at the northeast of the country near the Vietnamese border, has a population of 160,000 and high growth rate of population. (4.67% per annum), and main industry in the province is agriculture. Electrification rate in Rattanakiri province is low in comparison with other provinces and the rate is approximately 16%. Considered that Rattanakiri province is located in the mountainous and highland areas and has abundant water resources, Rattanakiri province has a great potential for hydropower development. However, only O'Chum No.2 Power Station whose maximum output is 960kW is presently operated in the province.

O'Chum No.2 Power Station has two reservoirs; one is O'Chum No.1 dam and another is O'Chum No.2 dam. However, head between these reservoirs which is about 23m is still unused. Therefore, it turns out that O'Chum No.1 Power Station utilizing a part of the existing O'Chum No.1 dam is studied in order to make effective use of the unused head. In addition, renewal of power generating facilities in O'Chum No.2 Power Station is also studied for the purpose of increase of the rated output as well as electric energy because it is found that the existing power generating facilities cannot generate electricity at the rated output.

3.2 Outline Design of the Requested Japanese Assistance

3.2.1 Design Policy

(1) Policy on Scope of Project

O'Chum No.1 Power Station is a development plan to divert a part of the existing O'Chum No.1 dam including incidental facilities such as intake, outlet, etc., to a part of this hydropower station. That's why it is needless to newly construct a dam, and the existing intake and outlet are adapted for hydropower generation facilities. On the other hand, most of the penstock and powerhouse are newly constructed.

As for renewal of the existing O'Chum No.2 Power Station, the power generation facilities such as turbine, generator, etc., are replaced with new ones, but the existing civil structures and hydro mechanical equipment such as dam, intake, gate, penstock, powerhouse, etc., are continuously used with minor repair, if required.

(2) Policy on Site Selection

Development plan of O'Chum No.1 Power Station is to make use of the unused head between O'Chum No.1 and O'Chum No.2 dams whose head is approximately 23m. However, a waterfall whose height is almost 8m exists between these dams, this waterfall is place for recreation and relaxation for local residents. Although head for power generation decreases unfortunately, the powerhouse is to be placed at the upstream of the waterfall in order to prevent the waterfall from drying up from the viewpoint of social environmental consideration.

Furthermore, all of the power generation facilities are to be placed within EDC's land for avoidance of both land acquisition and large-scale land transformation.

As for O'Chum No.2 Power Station, the existing electro mechanical equipment such as turbine, generator, etc., is merely replaced with new one, so that the place of the hydropower station is unchanged.

(3) Policy on Scale of Project

As for O'Chum No.1 Power Station, the scale is decided by means of mass curve method computed from inflow and outflow of O'Chum No.1 dam.

On the other hand, renewal of O'Chum No.2 Power Station is aimed at improving efficiencies of turbine and generator as much as possible.

(4) Policy on Operation of Power Station

O'Chum No.1 Power Station is a dam and conduit type hydropower station to which O'Chum No.1 dam supplies water. The reservoir impounds water in wet season and releases it in dry season. Thus this will enable the hydropower station to operate throughout the year with the averaged amount of water. Therefore, the reservoir operation shall be carried out appropriately so that the power station may generate power for peak load demand in dry season and for base load demand in wet season. Also, O'Chum No.2 Power Station shall be operated efficiently based on

the date of operation of O'Chum No.1 Power Station as well as observation of inflow water from a tributary flowing to the O'Chum No.2 reservoir.

(5) Policy on Natural Environmental Conditions

Due to lack of reservoir level, inflow and outflow of O'Chum No.1 dam, power generation of O'Chum No.1 Power Station is studied by means of inflow estimated from precipitation in Banlung city.

As for renewal of O'Chum No.2 Power Station, discharge for power generation and head are the same as the existing facilities, and consequently natural environmental condition is unchanged.

(6) Policy on Social and Economical Conditions

The main industry of Rattanakiri province is agriculture and its population is no more than 160,000. The growth rate of population is comparatively high of 4.67% per annum, as compared to that of the whole Cambodia being 1.55%. Electrification rate in urban area is 87%, while that in Rattanakiri Province is as low as 16%. Power demand of this province from 2007 to 2011, however, has shown a tremendous growth of 22.5% in annual average. Black out has occurred frequently, because power supply system has not been arranged sufficiently against rapid growth of power demand. Therefore most of governmental offices, hospitals and hotels have equipped with private owned generators. And there are a lot of villages near Banlung city where no connection of electricity supply has been made. The rate of poverty group here is as high as 46.11%, which is relatively high in the entire Cambodia.

For this reason, it is required to supply energy of high quality to cope with the rapid increasing power demand and to avoid power black out. This project will serve to solve these issues.

(7) Policy on Procurement of Materials & Equipment for Construction

All material for civil and architectural works can be procured in the local market. And, general construction machinery can be arranged in Phnom Penh which is the capital of Cambodia. As for turbine and generator, those made in Japan are supplied taking into consideration that this project is carried out as a part of "Promotion of Green Growth" in accordance with the scheme of the Japan's grant aid. And, most of hydro mechanical equipment such as steel penstock, gate and screen are locally procured, but some items such as valve, flange, etc., are supplied from third countries.

(8) Policy on Utilization of Local Contractor

Since number of power station in Cambodia is few, local contractors have little experiences in construction of power station as subcontractor. Therefore, Study Team has an opinion that Japanese contractor who has is much experienced is to construct O'Chum No.1 Power Station and to renovate O'Chum No.2 Power Station. However, considering that it is desirable in the future to construct hydropower station by Cambodian contractor, Study Team thinks it is favorable that local contractors take part in this project as subcontractor in order to gain their

experience.

(9) Policy on Capacity for Operation & Maintenance of Implementation Organization

EDC Rattanakiri, who operates both O'Chum No.1 and O'Chum No.2 Power Stations after the completion of this project, operates and manage the existing O'Chum No.2 Power Station, so that he has basic technique and knowledge to operate and manage a hydropower station. However, since not only up-to-date digitized equipment is installed but also operators are required to operate these hydropower stations in coordination between both power stations, more advanced technique and knowledge are required for operators. Therefore, soft component is aiming at doing better of technique and knowledge for operation and management of hydropower station.

(10) Policy on Schedule for Procurement & Construction

This project will be carried out in accordance with the scheme of Japan's Grant Aid, so that the procurement and installation are required to be finished within two years after the conclusion of G/A. In order to complete this project and to bring the expected results, works executed by both Japan's Grant Aid and Cambodia side shall be smoothly carried out in cooperation. In addition, since electro mechanical equipment is programmed to be procured in Japan and to be shipped to Cambodia, it is necessary to make out a project schedule in consideration of shipping route, system, time including custom clearance, etc., so as to arrive electro mechanical equipment at the construction site according to the progress of this project. Outline of the project schedule is shown as below;

[1st year]

Conclusion of the Grant Aid between the Governments of Japan and the Kingdom of Cambodia for detailed design and construction

Detailed Design

Preparation of draft of bidding document

Bidding

Commencement of the construction

[2nd year]

Execution of construction

Execution of soft component for technical guidance

Completion of the project

By the way, it is concluded that detailed investigation of the box culvert in the dam body is to be carried out in the detailed design stage. Because this investigation shall be executed under the condition that water inside the box culvert is drained out just before rainy season when the reservoir level absolutely comes down, it is required to pay attention to when the Grant Aid is concluded.

3.2.2 Basic Plan

3.2.2.1 New Construction of O'Chum No.1 Power Station

(1) Hydropower Planning

O'Chum No.1 dam was constructed in order to supply water to O'Chum No.2 Power Station existing approximately 2 km downstream of O'Chum No.1 dam during dry season when inflow to O'Chum No.2 dam decreases. Since head between O'Chum No.1 and No.2 dams which is almost 23 m high still remains unused, hydropower generation by means of the unused head is proposed to be studied. However, it is found that waterfall whose height is almost 8m exists between O'Chum No.1 and No.2 dams, which is place of recreation and relaxation for local residents. To prevent the waterfall from drying up due to arrangement of power station, it is decided to place the powerhouse at between O'Chum No.1 dam and the waterfall, and it is considered that water discharged from the powerhouse flows to the waterfall. As a result of the study, the powerhouse is arranged at approximately 200m downstream of O'Chum No.1 dam and 60 m upstream of the waterfall, and consequently effective head is estimated as 14.85 m.

In the hydropower planning, reservoir operation of O'Chum No.1 dam after the installation of the power station is indirectly studied by means of mass curve method on the basis of inflow data estimated from precipitation in Banlung city because EDC replied to our questionnaire that any record of hydrological data such as inflow, outflow, reservoir level, etc., doesn't exist. As a result of the study, it is estimated that mean dairy discharge for power generation is 0.54m^3/s in dry season from November to April.

Considered of the existence of O'Chum No.1 dam, O'Chum No.1 Power Station is proposed as reservoir type power plant. Characteristic feature of reservoir type power plant is to be able to impound water in a reservoir during wet season and produce electric power by using impounded water in dry season and to generate electric power depending on load fluctuation in difference form run-off type power plant. As a result of the site survey, it is found that time periods of peak demand of electricity in Banlung city are from 9:30 to 11:30 and from 17:00 to 20:00. Assumed that the aforesaid mean dairy discharge in dry season, 0.54m^3/s, is intensively used for the above peak demand hours, the maximum discharge for power generation is computed as below:

$$0.54m^3/s \times {24hr}/{5hr} = 2.6m^3/s$$

On the assumption that combined efficiency of turbine and generator is 0.70, the maximum output is computed as below.

$$P_{\max} = gQH_e\eta = 9.8m/s^2 \times 2.6m^3/s \times 14.85m \times 0.70 = 264.9kW \approx 265kW$$

P_{max} : Maximum output

G : Gravity acceleration

Q : Discharge for power generation

H_e : Effective head

η : Combined efficiency of the turbine and the generator

By the way, as for condition of variation of effective head specified from viewpoint of prevention of cavitation of a turbine, our electro mechanical engineer requests that ratio of the minimum effective head to the maximum one of cross flow turbine which will be applied to O'Chum No.1 Power Station is to be more than 70%. Due to this condition, lowest reservoir level for operation for O'Chum No.1 dam is modified from EL.279.00m to EL.287.00m, and consequently effective storage capacity is also modified from $12.7\times106m^3$ to $6.8\times106m^3$.

(2) Civil Facility

(a) Intake

The intake is arranged at the upstream of the existing intake tower after removal of a part of the existing conduit. Regarding vertical position of the intake, the following shall be considered:

i. In order to prevent sedimentation from entering into waterway, intake shall be placed at higher position than the bottom of reservoir.

ii. In spite of water intake in lowest water level, any vortex and/or air isn't taken away into waterway. In general, depth from lowest operation level to the top of invert concrete of intake shall be more than twice of diameter of waterway.

Considering that the top of the base concrete of the intake is presently EL.277.40m and that lowest water level is proposed to be modified from EL.279.00m to EL.287.00m, the surface elevation of the base concrete of the newly-constructed inlet is EL.282.20m. Additionally, screen is placed at the inlet in order to prevent foreign matter from getting into the waterway. Although the intake tower and the access bridge between the intake tower and the dam crest are reused for a part of components of the power station, the intake gate is replaced with new one.

(b) Waterway

According to "O Chum Hydroelectric Power Project – Project Appraisal" compiled by Meritec in 2002, it was reported that reinforced concrete culvert whose internal dimension is 1.5m×1.5m is embedded in the dam body. Although we requested EDC to provide us with the related drawings and design documents during this survey, any related drawing and design document haven't been handed over to us, and EDC explained that drawings and design documents might have been lost in the takeover of the facilities from MIME to EDC. Moreover, internal inspection of the culvert under dry condition could not be executed during this survey for the reasons that this survey was carried out in rainy season

when the reservoir water level was high and that the intake gate did not work well. Consequently, it comes to the conclusion that the inspection of the culvert from the inside shall be done in the detailed design stage, and it is assumed in the basic design that the culvert can be used as a part of components for the waterway.

However, in case that concrete culvert is applied to a pressure conduit, there is a concern that water may leak from joint between culverts and through crack in a conduit. So, it is proposed to insert steel pipe into the culvert for water sealing and to pour concrete or mortar into the gap between the culvert and the steel pipe for fixation of the pipe.

Additionally, bifurcation is arranged at downstream of the dam. One waterway connects to outlet works, and another waterway goes to the powerhouse. The reason to place outlet works is that water supplies to O'Chum No.2 Power Station in spite of stoppage of O'Chum No.1 Power Station in case that reservoir level of O'Chum No.1 dam is over the lowest water level.

Most of steel pipe between the above bifurcation and the powerhouse is exposed type. And, the exposed steel pipe is supported by saddle support which is basically arranged every 6 m according to one of Japanese Standard named as "Technical Standard for Gate and Steel Pipe".

Thickness of the steel pipe is computed as 6mm which is the minimum thickness under the condition that internal pressure rises up to thirty percents in shut down in accordance with "Technical Standard for Gate and Steel Pipe".

Outlet structure is composed of main and auxiliary outlet works in accordance with "Technical Standard for Gate and Steel Pipe". Jet flow gate (or valve) and high-pressure slide gate (or valve) are selected as main and auxiliary outlet works respectively.

(c) Powerhouse & Tailrace

Basic policy for arrangement of the powerhouse is to place the powerhouse as downstream as possible in order to enlarge head. However, in consideration of JICA's GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS, it is desired that new power station doesn't affect the waterfall existing between O'Chum No.1 and No.2 dams. Consequently, the powerhouse is arranged at a bit of the upstream of the waterfall where the powerhouse is unseeable from the basin of the waterfall. And also, the existence of the outlet of the spillway is considered for prevention of submergence by flood.

According to request from electro mechanical side, internal dimensions of the powerhouse are a height of 4.0m, a longitudinal length of 8.0m and a width of 8.0m. And also, center of the turbine is set at EL.275.00 m in consideration of topographic feature, conditions for the installation of the turbine that heights from the center of the turbine to the floor and tailwater level are 0.85 m and 1.75m respectively.

(d) Administrative Road

The administrative road for O'Chum No.1 Power Station branches from the road on the dam crest near the left abutment of the dam and heads for the powerhouse via the vicinity of the outlet valve room. After passing the valve room, the administrative road is arranged along the penstock.

The outline of the civil facilities is shown as shown in Table 3.2.2.1-1.

Table 3.2.2.1-1 Outline of the Civil Facilities of O'Chum No.1 Power Station

Name of Facilities	Unit	Q'ty	Notes
Intake	LS	1	Pressure Type, Screen
Waterway	m	332	Embedded Steel Pile (dam section) & Exposed Steel Pipe, Diameter: 1.0m to 1.5 m
Powerhouse & Tailrace	LS	1	Ground Type (Indoor Type), Single Story Building, Floor Area: 64m^2
Administrative Road	m	624	Width: Roadway 3.0m, Shoulder 1.0m (=0.5 m+0.5 m)

(3) Electro Mechanical Facility

The design policy for the system is to ensure high reliability and safety, to be compatible with the existing facilities for easy operation and maintenance, and to be fixable for future expansion considering the current technical level of EDC, Cambodia. The design will be formulated under the following criteria:

General Requirements of Electric Power Technical Standards	(Cambodia)
Specific Requirements of Electric Power Technical Standards	(Cambodia)
Japanese Industrial Standards	(JIS)
Japanese Electro Technical Committee Standard	(JEC)
Japanese Cable Standard	(JEC)
International Electrotechnical Commission	(IEC)
Other International Standard	(ISO)

The site election works for the project facilities shall be carried out in accordance with the regulation and/ or practices of EDC. And also the project shall be executed taking into account all necessary safety measures to the public and workers at the erection sites.

1) Basic Design Concepts of Hydroelectric Power Facilities

The electric facilities should be designed considering economic efficiency and technical capability for easy operation and maintenance. The currently applied standards for electrical and transmission/ distribution lines facilities in Cambodia is as follows:

Transmission line voltage	:	22 kV, 3-phase, 3-wire
Distribution line voltage	:	400/230 V, 3-phase, 4-wire
Frequency	:	50 Hz

As for the basic design of hydroelectric power facilities, it is applied the above standards of Cambodia in considering of operation and maintenance after commissioning. The hydro turbine, the power generation facilities and the distribution lines in this project were planned in accordance with the following concept:

(a) Selection of turbine type

Turbine type selection is basically determined by effective head and water discharge. As can be seen from the natural conditions at sites, the Francis turbine and Cross-flow turbine are suitable for medium head.

However, the Francis turbine is more complex in structure and expensive than the Cross-flow turbine and it can be still more expensive if the discharge is low, because it becomes small size and its fabrication becomes more difficult. Moreover repair is difficult when it is out of order due to cavitations or the like after the commencement of operation.

Compared with Francis turbine, the Cross-flow turbine is simple in structure and economical for medium head and low water discharge, so it was decided to apply Cross-flow turbine for the project.

Turbine control generally takes place by installing a guide vane servomotor (automatic control) which regulates water consumption and speed in accordance with the demand (actual load).

(b) Selection of generator type

Generator voltage is applied of 3-phases, 400 volts, AC considering standards voltage in Cambodia. The high revolving speed of generator is basically economic efficiency because of small body with low weight than low speed machine. Therefore, it is installed a speed increasing gear or belt at the connecting portion of the turbine-generator to increase the revolving speed of the generator, thus making the generator weight as small as possible and achieving an economy. The generator revolving speed is applied to be approximately 1,000 rpm.

(c) Operation and control method of power plant

The monitoring and control of the power plant should take place by resident operators at O'Chum No.2 Power Station, and basically these should be by the constant continuous monitoring and control method.

Control method	:	unmanned power plant by the continuous monitoring and control method
Load control	:	Automatic control by governor

(d) System parallel operation

The turbine-generator is run continuously, and the generated power is boosted to 22kV through a step-up transformer and is connected to the transmission and distribution system.

2) Basic Design of Hydropower Plant

According to the results of a survey of river discharge, effective head and efficiency, an installed capacity shall be as follows;

Installed capacity=9.8×2.6m^3/s×14.85m×0.7=265kW

Discharge	:	2.6 m^3/s
Effective head	:	14.85m
Efficiency	:	70%

The design summary is given below:

(a) Equipment design summary

i. Turbine

Type	:	Cross flow turbine
Governor	:	Static type governor motor driven
Flywheel	:	Necessary flywheel (Manufacturer recommended)
Inlet valve	:	Butterfly type with motor driven
Rating	:	As shown in Table 3.2.2.1-2

ii. Generator

Type	:	3 phase induction generator
Frequency	:	50Hz
Connection	:	3-phase, 3-wire
Insulation	:	F class
Rating	:	As shown in Table 3.2.2.1-2

iii. Control board

Type	:	Indoor, self stand type with front door
Control, protective devices	:	A set of instruments, protective relays, AVR and governor control devices, magnetic switches and others.

Table 3.2.2.1-2 Turbine and Generator Data

Description		**O'Chum No.1**
Turbine	No. of Unit	1
	Effective Head (m)	14.85
	Discharge (m3/s)	2.6
	Output (kW)	295
	Rotating Speed (rpm)	174
Generator	No. of Unit	1
	Capacity (kVA)	350
	Voltage (V)	400
	Power Factor	0.8
	Rotating Speed (rpm)	1,000
Installed Capacity (kW)		265

The combined efficiency of the turbine-generator was taken at approximately 70%, assuming that it would be possible to secure a turbine efficiency of approximately 78%, a speed increasing gear efficiency of approximately 97 % and a generator efficiency of approximately 93 % or so.

(b) Operation and control method of power plant

The monitoring and control of the power station should take place by resident operators from O'Chum No.2 Power Station, and basically these should be by the constant continuous monitoring and control method. It should be equivalent to an unmanned power plant by the continuous monitoring and control method. Turbine-generator can be started and stopped by the open or close of the inlet valve in automatic operation and also can be run in parallel from control panel by synchronizer into the 22 kV power system. Moreover, relevant information such as output, voltage, current and water level will be sent to EDC Rattanakiri office.

(c) Protective method

The protective method of the power generation facility should consist of two types of protection: emergency shutdown and alarm.

a) Emergency shutdown

In case of heavy fault such as electrical and mechanical failures, a protective relay forces the circuit breaker of the generator main circuit to trip in order to disconnect the circuit from the system, as well as to shut off the turbine generator and lock the starter circuit. On the operation control board, there should be an integrated failure and operation indicator which should display the status and alert the resident operators to O'Chum No.2 Power Station. When the failure has been completely eliminated, it should be possible to restore the starter circuit manually to the normal state.

b) Alarm

When an alarming failure occurs, the integrated failure and operation indicator on the operation control board should display the status and alert the resident operators to O'Chum No.2 Power Station of the failure by a buzzer.

The bell and buzzer alarm should automatically stop after a certain length of time, or it should be possible to stop it manually.

(d) Step-up Transformer

The Step-up transformer will be provided under the project and designed concept as follows.

The Step-up transformer capacity will be 350kVA with accessory of surge arrester and meter box, etc. The major features of the above substations are as follows:

•· Type	:	Three-phase, outdoor oil immersed type with no-load tap changer Tap changer (±5%, 5-steps)
• Capacity	:	350 kVA
• Voltage ratio		
Primary side	:	22 kV, 3 phase, 3 wire system
Secondary side	:	400-230V, 3 phase, 4 wire system
• Voltage group	:	Dyn11
• Cooling system	:	ONAN

(e) 22kV Incoming and Outgoing Feeder Cubicle

The 22 kV feeder cubicles and transformer primary circuit cubicles will be of self-supporting, metal-enclosed indoor type. The cubicles will be consisted of circuit breaker, load break switch and buses.

• Rated voltage and frequency	:	22 kV, 50Hz
• Composition	:	Circuit breaker, Load break switch, Buses
• Rated current		
For feeder circuit	:	630A
• Short circuit current	:	31.5 kA (0.1second)
• Control mode	:	Auto and Manual operation mode

3) Grounding Works

All equipment in out/indoors and other metal parts required for safe operation will be grounded by means of more than 35 mm^2 copper cable and ground rods. Cooper coated steel rods will be used for grounding. The grounding resistance for neutral terminal of distribution transformers shall be of less than 10 ohm.

(4) Distribution Line Facilities

1) Design Concept

There is an existing distribution line along the road on the top of O'Chum No.1 dam. Therefore new 22kV distribution line construction is planned along the administrative road for O'Chum No.1 Power Station.

When designing the new distribution line, technical standards in Cambodia and design standard of EDC have to be applied. And design and equipment applied for existing EDC facilities should be used in order to keep high safety and reliability. Regarding a conductor, partial insulated conductor (PIC) should be used in order to minimize tree-cutting and to prevent earthing fault and short circuit.

(a) Applied Standard

The design will be formulated under the following criteria:

General Requirements of Electric Power Technical Standards	(Cambodia)
Specific Requirements of Electric Power Technical Standards	(Cambodia)
Design Standard	(EDC)
International Electrotechnical Commission	(IEC)
International Organization for Standardization	(ISO)
Other International Standard	

The site work for the project facilities shall be carried out in accordance with the regulation and/ or practices of EDC. And also the project shall be executed taking into account all necessary safety measures to the public and workers at the sites.

(b) Voltage Levels

The voltage in the medium distribution line system of Cambodia is adopted 22kV. Moreover, the existing medium voltage distribution line is 22kV. Therefore the medium voltage system is enacted as 22 kV.

Table 3.2.2.1-3 System Voltage

System	Voltage level & Phases
Medium voltage distribution system	22kV, 3-phase, 3 –wire
Low voltage distribution system	400/230V, 3-phase, 4-wire

(c) Basic Conditions

With reference to the Electric Power Technical Standards and Design Standard of EDC, the design conditions for the facilities to be provided under the Project will be adopted as follows:

Table 3.2.2.1-4 Design Conditions of the Transmission and Distribution

Design Parameter	Design Value
Design wind pressures	
Conductors	520 Pa/m^2
Poles (round)	680 Pa/m^2
Insulators	900 Pa/m^2
Cross arm and Other equipment	1,410 Pa/m^2
Ground temperature maximum	25ºC
Sag and tension	
maximum sag occurs at	75 ºC, still air
maximum stress occurs at	13 ºC, maximum wind
every day stress (EDS) occurs at	27 ºC, still air
factor of safety at maximum stress	2.5 against UTS
factor of safety at EDS	4.0 against UTS

(d) Electrical Design Parameters

The electrical design parameters shown in Table 3.2.2.1-5 and Table 3.2.2.1-6 will be adopted for the MV and LV distribution systems:

a) 22kV MV Electrical Design Parameter

Table 3.2.2.1-5 MV Electrical Design Parameter

Design Parameter	Design Value
Distribution system	3 phase, 3 wire system
Nominal system voltage	22 kV
Maximum system voltage	24 kV
Rated impulse voltage withstand (peak)	125 kV
Rated power-frequency withstand voltage (1 min, rms.)	50 kV
Rated short-time current (0.1 sec.)	31.5kA
Rated peak short-circuit current (peak value)	50KV
Rated frequency	50 Hz

b) 400V-230V LV Electrical Design Parameter

Table 3.2.2.1-6 LV Electrical Design Parameter

Design Parameter	Design Value
Distribution system	3 phase, 4 wire system
Nominal system voltage	400/230 V
Maximum system voltage	424/244 V
Rated power-frequency withstand voltage (1 mint, rms.)	2,000 V
Rated impulse voltage withstand (peak)	6,000 V
Rated frequency	50 Hz

(e) Earthing System

The earthing for the MV and LV distribution system are shown in Table3.2.2.1-7.

Table 3.2.2.1-7 Grounding System

Particular	System
a) MV distribution system	Low-resistance grounding system
b) LV distribution system	Solid grounding system

(f) Clearance

a) Overhead distribution lines

The minimum clearance for conductors shown in Table 3.2.2.1-8 will be adopted.

Table 3.2.2.1-8 Minimum Clearance

Particular	Minimum Clearance (meters)
Clearance above ground - 22 kV	
across the road	8.0
along the road	6.5
Others	6.5
Clearance above ground – LV	
across the road	6.5
along the road	5.5
Others	5.5

(g) Voltage Variation

The voltage variation shown in Table 3.2.2.1-9 will be kept to ensure a quality supply at end of the distribution line and/or the customer's switchboard:

Table 3.2.2.1-9 Voltage Variation

Voltage Level		Voltage Variation
MV network	22 kV	± 5%
LV network	400/230 V	+ 10% ~ - 6 %

2) Project Area and Project Facilities

(a) Project area

The object district of the Project is Banlung city in Rattanakiri province located in the northeastern part of the Cambodia.

(b) Project facilities

The facilities to be provided under the Project are as shown in Table3.2.2.1-10.

Table 3.2.2.1-10 Facility to be provided under the Project

No,	Item	Unit	Amount
1	New medium voltage line		
	Overhead line	km	0.73
	Total	km	0.73
2	Spare items	L.S.	1

3) Distribution Line Facilities

The overhead and underground distribution line facilities to be provided for the project are as follows.

(a) Overhead line support

Supports for overhead lines are to be of steel reinforced concrete pole, with 12 m long for MV distribution lines. The poles will be set in the concrete foundations. The height of poles was decided as Table 3.2.2.1-11.

Table 3.2.2.1-11 Study on Overhead Line Support

Span	**MV Line (m)** **50**
Minimum height of conductor above ground	8.00
Maximum sag of conductor	1.01
Minimum height of conductor above ground	0.25
Allowance of ground clearance	0.74
Depth of pole	2.00
Total (necessary pole height)	12.00
	MV Line (m)

(b) Insulators

Pin or pin-post and string insulators are to be used for supporting the 22 kV line conductors. The conductors will be fixed to the insulators by insulated annealed aluminum bind wires.

(c) Conductors

In the cause of the overhead distribution line faults, the majority is arising from the short circuit faults due to contact the line to line or earth faults due to contact the line to tree of the bare distribution line conductors. As these faults measures, the covered conductor is adopted in the Banlung city because there are a lot of trees.

Taking account of the above, all aluminum conductor covered with cross linked polyethylene (XLPE) will be used as follows:

i) MV overhead line
- Covered conductor : 70sq.mm × 1-core all aluminum conductors with cross linked polyethylene cover (PIC)

(d) Cross arms

The conductors of the MV overhead distribution lines will be arranged in horizontal-formation for a circuit on the straight pole. The arms are to be fixed to the pole with two through bolts.

(e) Lightning arresters

Lightning arresters will be of 24 kV, 10 kA non-linear resistor type and mounted on the end

of lines, at the joint of underground cables and overhead lines.

(f) Grounding

The transformer, lightning arrester, switch case and other metal parts required for safe operation will be grounded by means of a grounding rod. Copper coated steel rods will be used for grounding.

3.2.2.2 Renewal of O'Chum No.2 Power Station

(1) Renewal Planning

O'Chum No.2 Power Station was constructed in cooperation with Vietnam and completed in 1993, and almost twenty years have passed since the completion. Because this power station hasn't been maintained well, it is cleared that the present output of this power station was almost 820kW at best even though the rated output is 960kW. The main reason is supposed to be deterioration of the turbine efficiency brought by damage of the runner vane and/or expansion of the runner seal due to cavitation. In addition, deterioration of bearing of turbine/generator due to long period operation are also suspected the efficiency decrease to be part of the reason that the existing O'Chum No.2 Power Station cannot generate electric power at the rated output. And, although there is nothing to directly do with the deterioration of the efficiency of the turbine and generator, it is found that deterioration of excitation of the generator and some control panels are damaged and that some auxiliary machines deteriorate significantly. Judging from the above, the existing electro mechanical equipment including control panels and auxiliary devices shall be replaced with new one.

Since the renewal of 'Chum No.2 Power Station is to replace only the existing electro mechanical equipment with new one, amount of water for power generation and head are unchanged. However, both output and electric power energy are expected to increase in comparison with the present due to improvement of efficiencies of turbine and generator. Furthermore, coordination with O'Chum No.1 Power Station which is newly constructed will bring effective operation of O'Chum No.1 and No.2 Power Stations.

(2) Civil Facility

As a result to survey whether the existing civil structures of O'Chum No.2 Power Station are sound or not, it is found that most of the civil structures can be regarded as sound. But, the following four portions are considered to be necessary to be mended.

1) Trashrack at Intake

Trashrack in front of the intake seems to be unfixed. And, the spacing between bars of the trashrack is too wide to stop relatively large suspended solid, and consequently they flow toward the waterway. Therefore, this trashrack shall be repaired.

2) Slope Protection of Tailrace

Since it is found that a part of slope protection along the tailrace is collapsed, the slope

protection shall be repaired.

3) Floor Finishing Concrete

Since it is found that a part of floor finishing concrete in the powerhouse is embossed, the floor finishing concrete shall be repaired.

4) Administrative Road

The surface of the administrative road between National Highway No.78A to O'Chum No.2 Power Station is eroded heavily, and the road condition is regarded as far from acceptable condition. In case of accident in O'Chum No.1 Power Station, it is supposed that operators which permanently stay in O'Chum No.2 power station cannot go in a harry to O'Chum No.1 Power Station. As for pavement, low cost pavement, not gravel road, is applied in consideration of the gradient for fear that base is eroded again after gravels outflow due to heavy rain.

(3) Electro Mechanical Facility

1) Basic Design Concepts of Hydroelectric Power Facilities

As for the designing of hydroelectric power facilities of O'Chum No.2, existing facilities such as powerhouse building, penstock and draft tube will be utilized in the future and therefore, electric power facilities shall be designed to conform with the utilized facilities.

The electric facilities should be designed considering economic efficiency and technical capability for easy operation and maintenance. The currently applied standards for electrical and distribution lines facilities in Cambodia is as follows:

Existing data of electric facilities are as follows;

Turbine output	:	480 kW
Turbine type	:	Horizontal shaft francis turbine
No. of turbine	:	2 units
Rotating speed of turbine	:	750 rpm
Discharge	:	1.875 m^3/s (per unit)
Effective head	:	31 m
Generator output	:	600 kVA
Generator type	:	Horizontal shaft 3 phase synchronous generator
Rotating speed of generator	:	750 rpm

(a) Selection of turbine type

Turbine type selection is basically determined by effective head and water discharge. However, horizontal shaft francis turbine shall be employed because of utilization of existing powerhouse building, penstock and draft tube and so on.

(b) Selection of generator type

As for the selection of generator type, it is also same reasons and conditions of selection of

turbine such as utilization of power house building, penstock and draft tube. Therefore, horizontal shaft 3 phase synchronous generator shall be employed accordingly.

(c) Operation and control method of power plant

The monitoring and control of the power plant should take place by resident operators at O'Chum No.2 Power Station, and basically these should be by the constant continuous monitoring and control method.

Control method	:	continuous monitoring, control method and generator voltage controlled by AVR
Load control	:	Automatic control by governor

(d) System parallel operation

The turbine-generator is run continuously, and the generated power is boosted to 22kV through a step-up transformer and is connected to the transmission and distribution system.

2) Basic Design of Hydropower Plant

According to the results of a survey of river discharge, effective head and efficiency, an installed capacity shall be as follows;

Installed capacity = 9.8×1.875 m^3/s×31.0m×0.85= 480 kW

Discharge : 1.875m3/s

Effective head : 31.0m

Efficiency : 85%

The design summary is given below:

(a) Equipment design summary

i. Turbine

Type	:	Horizontal shaft francis
Governor	:	Static type governor motor driven
Flywheel	:	Necessary flywheel (Manufacturer recommended)
Inlet valve	:	Butterfly type with motor driven
Rating	:	As shown in Table 3.2.2.1-1

ii. Generator

Type	:	3 phase synchronous generator
Frequency	:	50Hz
Connection	:	3-phase, 3-wire
Insulation	:	F class
Rating	:	As shown in Table 3.2.2.1-1

iii. Control board

Type	:	Indoor, self stand type with front door

Control, protective devices : A set of instruments, protective relays, AVR and governor control devices, magnetic switches and others.

Table 3.2.2.2-1 Turbine and Generator Data

Description		O'Chum No.2
Turbine	No. of Unit	2
	Effective Head (m)	31.0
	Discharge (m^3/s)	1.875
	Output (kW)	507
	Rotating Speed (rpm)	750
Generator	No. of Unit	2
	Capacity (kVA)	600
	Voltage (V)	400
	Power Factor	0.8
	Rotating Speed (rpm)	750
Installed Capacity（kW）		480 × 2 = 960

The combined efficiency of the turbine-generator was taken at approximately 85 %, assuming that it would be possible to secure a turbine efficiency of approximately 89 % and a generator efficiency of approximately 95 % or so.

(b) Operation and control method of power plant

The monitoring and control of the power plant should take place by resident operators at O'Chum No.2 Power Station, and basically these should be by the constant continuous monitoring and control method. It should be equivalent to an unmanned power plant by the continuous monitoring and control method. Turbine-generator can be started and stopped by the open or close of the inlet valve in automatic operation and also can be run in parallel from control panel by synchronizer into the 22kV power system. Moreover, relevant information such as output, voltage, current and water level will be sent to EDC Rattanakiri office.

(c) Protective method

The protective method of the power generation facility should consist of two types of protection: emergency shutdown and alarm.

i. Emergency shutdown

In case of heavy fault such as electrical and mechanical failures, a protective relay forces the circuit breaker of the generator main circuit to trip in order to disconnect the circuit from the system, as well as to shut off the turbine generator and lock the starter circuit. On the operation control board, there should be an integrated failure and operation indicator which should display the status and alert the resident operators.

When the failure has been completely eliminated, it should be possible to restore the starter circuit manually to the normal state.

ii. Alarm

When an alarming failure occurs, the integrated failure and operation indicator on the operation control board should display the status and alert the resident operators of the failure by a buzzer.

The bell and buzzer alarm should automatically stop after a certain length of time, or it should be possible to stop it manually.

(d) Step-up Transformer

The Step-up transformer will be provided under the project and designed concept as follows.

The Step-up transformer capacity will be two (2) sets of 600kVA and surge arrester is to be used as existing one. The Step-up transformer will be installed at outdoor of existing base ground.

The major features of the above substations are as follows:

- Type : Three-phase, outdoor oil immersed type with no-load tap changer
  Tap changer (±5%, 5-steps)
- Capacity : 700kVA
- Voltage ratio
  Primary side : 22 kV, 3 phase, 3 wire system
  Secondary side : 400-230V, 3 phase, 4 wire system
- Voltage group : Dyn11
- Cooling system : ONAN

(e) 22 kV Incoming and Outgoing Feeder Cubicle

The 22 kV feeder cubicles and transformer primary circuit cubicles will be of self-supporting, metal-enclosed indoor type. The cubicles will be consisted of circuit breaker, load break switch and buses.

- Rated voltage and frequency : 22kV, 50Hz
- Conposition : Circuit breaker, Load break switch, Buses
- Rated current
  For feeder circuit : 630A
- Short circuit current : 31.5 kA (0.1second)
- Control mode : Auto and Manual operation mode

3) Grounding Works

All equipment in out/indoors and other metal parts required for safe operation will be grounded by means of more than 35 mm^2 copper cable and connecting existing ground rods or wires. In case of additional grounding point, cooper coated steel rods will be used for grounding. The grounding resistance for neutral terminal of distribution transformers shall be of less than 10 ohm.

(4) Distribution Facilities

Existing 11 kV/22 kV transformer between 11 kV distribution lines of O'Chum No.2 Power Station and 22 kV distribution lines in O'Chum district is unnecessary because O'Chum No.2 Power Station will be designed to connect 22 kV distribution line from 400V/22 kV step-up transformer to outgoing 22 kV distribution line. Therefore, existing transformer should be removed from the existing lines, and to connect directly 22kV line to line. As for the scope of work, the Contractor will carry out the removing work and its line connection.

3.2.3 Outline Design Drawing

The preliminary design drawings of this project are shown in Table 3.2.3-1. DWG. No.1 to DWG. No.13 is shown in Appendix-6.

Table 3.2.3-1 Drawing List

No.	Title of Drawings
1	Location Map
2	O'Chum No.1 Power Station, General Plan
3	O'Chum No.1 Power Station, Waterway, Longitudinal Section
4	O'Chum No.1 Power Station, Waterway, Longitudinal Section (Dam Portion)
5	O'Chum No.1 Power Station, Powerhouse, Plan
6	O'Chum No.1 Power Station, Powerhouse, Longitudinal & Cross Section
7	O'Chum No.1 Power Station, Powerhouse Arrangement of Hydropower Generating Equipment, Plan and Section of Hydropower Generating Equipment
8	O'Chum No.1 Power Station, Single Line Diagram
9	O'Chum No.2 Power Station, Powerhouse, Plan
10	O'Chum No.2 Power Station, Powerhouse Arrangement of Hydropower Generating Equipment, Plan and Section of Hydropower Generating Equipment
11	O'Chum No.2 Power Station, Single Line Diagram
12	O'Chum No.1 Power Station, Route map Medium Voltage Distribution Lines
13	O'Chum No.1 Power Station, Medium Voltage Overhead Three Phase

3.2.4 Implementation Plan

This project is implemented in accordance with the framework of the Japan's grant aid scheme. Thus, the project is commenced after Exchange of Notes (E/N) is interchanged between Japanese

government and Cambodian government following approval of implementation of this project by Japanese government. The following shows basic policies and points to notice.

3.2.4.1 Implementation Policy

(1) Main Body of Implementation of Project

Cambodian main body to implement this project is EDC. Both headquarter of EDC in Phnom Penh and EDC Rattanakiri in Rattanakiri province where the project sites exist mutually cooperates for this project. EDC has already created a project team composed mainly by the Generation Department and appointed a project manager. EDC is ready for implementation of the project.

The project manager is requested to explain contents of this project to local residents as well as administration officials in Cambodian government and to win their understandings. In addition, the project manager shall call local residents' attention to safety and try to realize smooth execution of this project.

(2) Consultant

Since this project is requested to be successfully completed within the limited time, it is suggested that Japanese consultant executes both detailed design and supervision of this project. Therefore, Cambodia government is kindly requested to invite Japanese consultant to carry out the detailed design and supervision. And, services in related to a tender such as preparation of bidding document, prequalification, etc., are also included in the scope of the Japanese consultant.

(3) Contractor

As stated above, this project is implemented in accordance with the framework of the Japan's grant aid scheme. Therefore, a Japanese corporate body is selected as contractor of this project by Cambodian government through bidding, and the contractor executes procurement of materials and equipment, construction and installation related to this project.

(4) Procurement of Turbine & Generator

This project is implemented as part of "Promotion of Green Growth (Introduction & Promotion of New Energy)", so that turbines and generators which are heart of hydropower generation facilities are to be procured from medium-sized and small companies in Japan.

(5) Construction Machinery

As a result of the site survey, it is found that there is not any construction company and a company to rent construction machinery in both O'Chum village and Banlung city, which is the capital of Rattanakiri province, is located next to the village. Therefore, construction machinery is basically procured from Phnom Penh.

(6) Necessity to Dispatch Japanese Craftsman

As you know, there are a few hydropower stations in Cambodia, so that Cambodia has leaned

heavily upon foreign countries for construction of hydropower station. That's why number of skilled labor who has experience to be engaged on construction of hydropower station is significantly small. In addition, length of steel penstock is relatively long. Furthermore, since O'Chum No.1 Power Station is planned to insert steel pipe into the existing box culvert penetrating the dam body, the work space for welding and plumbing is so narrow. Consequently, skilled welder and plumber are required. So, Japanese skilled welder and plumber are dispatched for quality assurance of this project.

(7) Utilization of Local Construction Company

Although number of hydropower station is quite a few in Cambodia as mentioned above, it was found in the site survey that local construction company who took part in the construction project for O'Romis and O'Moleng hydropower stations completed in 2008, which were implemented in accordance with Japan's grand aid scheme, exists in Phnom Penh. Judging from his interview, it is supposed that technical capabilities of this construction company improve in comparison of 2008. The reason is that this construction company involves in large-scaled construction such as water supply facility, etc. after the completion of the above hydropower stations.

This project is a good opportunity to take part in a construction of a hydropower station for the construction company, and it is expected that the construction company will be essential to construct a hydropower station in Cambodia himself. Forward-thinking, it is suggested that the construction company subcontracts in this project.

3.2.4.2 Implementation Conditions

(1) Point of Concern for Recruit of Work Force in Cambodia

In Cambodia, it is possible to recruit work force for general construction. However, as mentioned in the previous section, there are few skilled labors required for construction of hydropower station. In addition, it is requested to complete this project within twenty four months from the grant agreement between Japanese and Cambodian governments because this project is implemented in accordance with the Japan's grant aid scheme. In order to keep this schedule with maintaining quality, it is essential to dispatch Japanese skilled labors to the construction site.

(2) Point of Concern for Detailed Design

Newly-constructed O'Chum No.1 Power Station is the hydropower project utilizing the existing facilities of O'Chum No.1 dam. However, according to EDC who is the present owner of O'Chum No.1 dam, there isn't any drawing and design document of O'Chum No.1 dam. Additionally, the study team couldn't comprehend the present conditions, dimensions, etc., of structures existing below the reservoir surface and embedded in the dam body because the site survey was carried out in rainy season when the reservoir level is high, and consequently the study team has no other choice to carry out the basic design under assumptions. Therefore, detailed inspection for such structures, especially the box culvert which steel penstock is inserted into, is required to be done in the detailed design stage under dry condition of the box culvert,

and the result shall reflect on the detailed design.

(3) Prerequisite for Construction of O'Chum No.1 Power Station

O'Chum No.1 Power Station is the hydropower project to utilize a part of the existing O'Chum No.1 dam for the newly-constructed hydropower station and the construction includes works in the reservoir. That's why the works in the reservoir shall be executed within dry season when not only precipitation is little but also the reservoir level is low. EDC is required to drain water from the reservoir, considering the status of rainfall. The reason is that it is indispensable to empty the reservoir for construction work of the intake facilities. On the other hand, this project is implemented in accordance with the Japan's grant aid scheme and is requested to be completed within twenty four months after the grant agreement between Japanese and Cambodian governments. In case that the works in the reservoir aren't finished in first dry season due to delay of grant agreement, detailed design, bidding for the construction, etc., there is a high possibility that this project isn't completed with twenty four months. Therefore, grant agreement, detailed design, bidding, etc., shall be carried out smoothly.

(4) Prerequisite for Renovation of O'Chum No.2 Power Station

Construction schedule of O'Chum No.2 Power Station will not be affected by the whether conditions in rainy and dry seasons, because renovation work for O'Chum No. 2 Power Station is inside of existing powerhouse. Therefore, the commencement date of the work is unlimited and no concerned civil work.

Renovation work will be planned in consideration of the following matters.

To save the storage area for removed existing equipment
To implement design reflecting existing base and powerhouse facilities
To make a disposal plan for work dusty environment
To make a plan of transfer technology to EDC for electrical equipment during disassembly.

3.2.4.3 Scope of Works

Demarcations of both new construction of O'Chum No.1 Power Station and renewal of O'Chum No.2 Power Station between Japan and Cambodia are shown as follow:

Table 3.2.4.3-1 Demarcation of Scope of Works between Japanese and Cambodian Sides

Item(s)	O'Chum No.1		O'Chum No.2	
	Japan	Cambodia	Japan	Cambodia
1. Supply of Land for the Project without Charge (including Land Expropriation)	---	○	---	○
2. Removal of Existing Intake & Outlet Works	○	---	---	---
3. Removal of Existing Hydropower Generating Facilities	---	---	○	---
4. Construction and Maintenance of Temporary Construction Road	○	---	---	---
5. Clearance and Maintenance of Access Road to Construction Site	---	○	---	○
6. New Construction or Renovation of Administrative Road	○	---	○	---
7. New Installation of Intake	○	---	---	---
8. New Installation of Pressure Conduit Line	○	---	---	---
9. New Installation or Renewal of Hydropower Generating Facilities	○	---	○	---
10. New Installation or Renewal of Outlet Works	○	---	○	---
11. New Installation or Renewal of Transmission & Distribution Facilities	○	---	○	---
12. New Construction of Staff Lodge & Storage	---	---	○	---

3.2.4.4 Consultant's Supervision

Consultant is requested to overlook works done by a contractor as a supervisor for the purpose that hydropower stations are newly-constructed or renovated within a specified time period to keep the specified qualities. Especially, construction schedule management and coordination among civil, electro mechanical, transmission & distribution works are important since these works are carried out in parallel. Therefore, the above permanent supervisor dispatched from a consultant is requested to check progresses of each work in the interface meeting held every month or week, and to urge a contractor to catch up with the specified construction schedule.

And, a permanent supervisor is to pay attention to supply of construction material, progress of manufacturing of power generation facilities, etc., for prevention against delay due to undelivered material and/or equipment. Especially, as for electro mechanical and electrical equipment such as turbine, generator, transformer, etc., their shop drawing shall be checked by consultant before commencement of manufacturing in avoidance of defect. After fabrication, consultant attends shop test and inspect whether equipment meet requirement or not. Moreover, consultant reviews methodology of shipment and temporary storage at the site in order to maintain quality.

Consultant organizes a project team in order to continuously supervise this project from detailed design to supervision. Among the team, one engineer is dispatched to the site at least and takes action

for smooth execution of works. In addition, engineer(s) is dispatched to the site according to progress of works related to hydro turbine and generator such as installation, adjustment, trial operation, etc., and supervise together with a permanent supervisor. Contents of construction supervision by consultants are shown in the following table.

Table 3.2.4.4-1 Contents of Construction Supervision by Consultants

Items	Necessary Consultants	Contents of Supervision
1. Supervision by consultant permanently stationed	1	Overlook of whole of the project
2. Supervision by consultant temporarily stationed		
Civil works	2	Supervision of intake, powerhouse, waterway
Architectural works	1	Supervision of buildings
Hydro-mechanical works	1	Review of manufacturer's drawings and documents Supervision of hydro-mechanical equipment
Electro-mechanical works	2	Review of manufacturer's drawings and documents Supervision of electro-mechanical equipment
Distribution works	1	Supervision of distribution line
Total	8	

3.2.4.5 Quality Control Plan

It goes without saying that hydropower stations constructed or renovated in this project shall meet requirements stipulated in specification. In addition, strength, dimension, tolerance, etc., of structure and equipment shall also meet specification. For confirmation, the following checks are executed. In case of unacceptability, the contractor is requested to execute correction, change, alter, etc. of unsatisfied material, structure, equipment, etc.

a. Checking of results of material tests
b. Checking of specification of equipment to be installed
c. Checking of results of shop tests including methodology of the test
d. Checking of methodology of packing, transportation and temporary storage of equipment
e. Checking of results of installations including methodology for installation
f. Checking of results of commissioning
g. Checking of dimensions of structures
h. Checking of strength of structures
i. Checking of results of trial operation
j. Checking of as-built drawings

3.2.4.6 Procurement Plan

The following table shows from where material and equipment are supplied for this project.

Table 3.2.4.6-1 Source of Supply of Material & Equipment

Material & Equipment	Cambodia	Japan	Third Country	Reasons not to Procure in Cambodia
Material and Machinery for Civil and Architectural Works				
Sand, Gravel, Crashed Stone	○			
Cement	○			
Reinforcing Bar	○			
Steel Penstock	○			
Joint for Steel Penstock			○	Flange and expansion joints cannot be manufactured in Cambodia.
Intake gate	○			
Intake Screen	○			
Discharge Valve			○	This equipment cannot be manufactured in Cambodia.
Building Material	○			
Construction Machinery	○			
Hydropower Generating Facilities				
Turbine		○		Japan's grant aid scheme
Generator		○		Ditto
Control Board		○		Ditto
Transformer		○		Ditto
Level Gauge (Pressure Type)		○		
Transmission & Distribution Facilities				
Concrete Column	○			
Electric Wire, Cable	○			
Switchgear, etc.	○			

And, routes of transportation of material and/or equipment supplied from Japan and/or third countries are shown in the following table.

Table 3.2.4.6-2 **Transportation Routes of Material and/or Equipment Supplied from Japan and/or Third Countries**

Items	Countries	Marine Transportation	Land Transportation
Turbines Generators Control Boards Water Level Gauge (Pressure Type)	Japan	Yokohama – Sihanoukville	Sihanoukville – Site
Joints of Steel Penstock Discharge Valve	Thailand	---	Bangkok - Site

In general, electro-mechanical equipment such as turbine, generator, control board, etc., are manufactured in Japan, Europe and the United States, so that it is hard to get parts in Cambodia. In addition, it is also difficult to maintain and repair equipment by maker's technician. Considered such circumstance, spare parts which are expected to be required for two years are supplied together with the plants. And, guarantee period will be one or two years in consideration of similar cases.

3.2.4.7 Operational Guidance Plan

(1) Guidance of Initial Run for Hydropower Station

As for the transfer technology to EDC staff before completion of the project, the Contractor will provide training about operation of turbine/generator, equipment of function, characteristics, procedure of inspection method and replacement of spare parts, etc. during construction period.

So that reflecting those activities, the Consultant plans to prepare in the "Operation and Maintenance Manual for Ratanakiri" in the soft component.

(2) Management of Operation and Maintenance Plan

EDC as an agency of the project, they have a knowhow of the management in the electric power industry field, but there are not so many experiences in the hydropower field. Furthermore, major equipment of No.1 and No.2 Power Stations will introduce new technology of the Japanese made.

On the other hand, EDC staff in Rattanakiri, they have an enough experiences for existing facilities, but it is necessary to reinforce about the technology of new equipment in order to step up organized management. As for the transfer of technology during OJT and soft component, it will be planned as follows. So that reflecting those activities, the Consultant plans to prepare in the "Operation and Maintenance Manual for Rattanakiri" in the soft component.

1) To attend and train the inspection procedure, test method and adjustment of parts
2) To maintain and procure the spare parts

3) To explain and train the understanding of instruction manuals

3.2.4.8 Soft Component (Technical Assistant) Plan

(1) Background

EDC currently owns three hydropower plants: O'Chum No. 2, O'Moleng and O'Romis power stations. All of them were constructed with overseas assistance. Thus, there is no hydropower plant that was developed solely by Cambodia. Although they have a certain level of maintenance capability at the three hydropower plants, they operate them manually.

O'Chum No.2 Power Station was constructed in cooperation with Vietnam and completed in 1993, and almost twenty years have passed since the completion. While taking over O'Chum No.2 Power Station from MIME to EDC, relevant drawings and design documents haven't been kept in the EDC Rattanakiri office. Moreover leakage record of O'Chum No.1 Dam, operation reocrod of discharge valve, spillway, water level of reservoir and operation maintenance manual also haven't kept in the EDC Rattanakiri office.

Eventhough since May 2012, distribution line between Rattanakiri and Vietnam has been connected and electric power system of Rattanakiri has been united with Vietnam electric power system, there have been still so many accidents.

The Cambodian government requests the Japanese government the following four matters through the request for grant aid and the letter issued on August 23rd, 2012:

1) Capacity building for hydropower engineering
2) Capacity building for distribution engineering

In this project, construction of 'Chum No.1 Power Station and replacement work of electro mechanical equipment for O'Chum No.2 Power Station are planned. Consequently, all equipment will be modernized and present manual operation will be digitalized and automatically. O'Chum No.1 Powe rStation will be operated from O'Chum No.2 Power Station and consequently effective reservoir operation and geration plan can be done.

Considered the above, the aforesaid 1) and 2) are executed as soft component (technical assistance) plan in order to enhance technical capabilities.

(2) Goal of Technical Assistance

The goal of this technical assistance is renovated and the related distribution grid are appropriately operated and maintained as a result of transfer of knowledge and skill to stuffs in EDC Rattanakiri.

(3) Outcome of Technical Assistance

(a) Achievement to build up how to operate and maintain civil structures

(b) Achievement to build up how to operate and maintain hydropower station

(c) Achievement to build up how to operate and maintain distribution lines power system

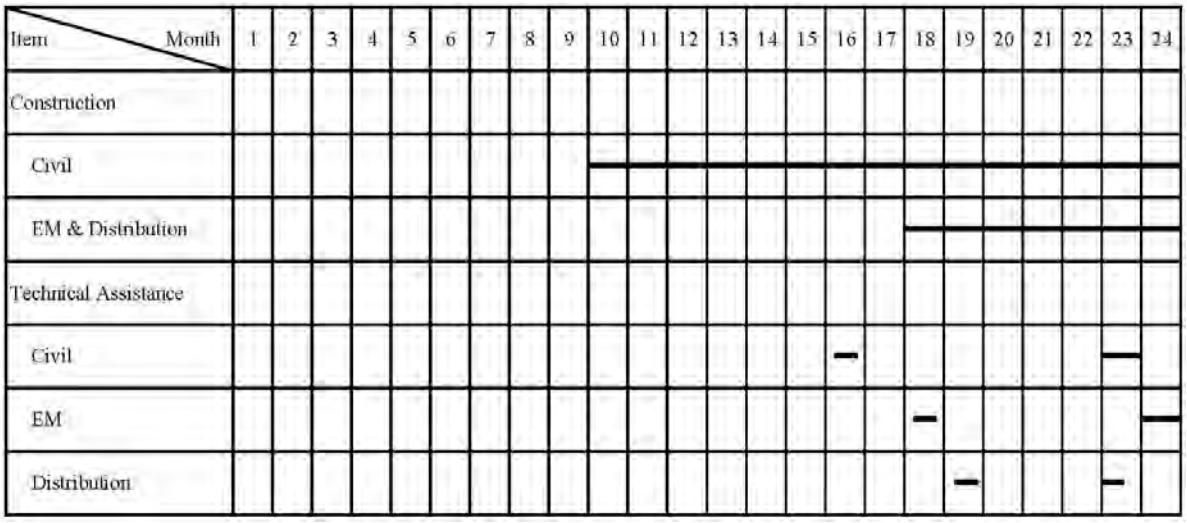
(4) Confirmation of Outcome

The aforesaid outcomes are confirmed by the following, and they are written in the completion report finally. And, indicator to measure level of proficiency will be set in accordance with during the implementation of this technical assistance.

(5) Implementation Schedule

The schedule to implement the soft component is shown in Table 3.2.4.8-1 as below.

Table 3.2.4.8-1 Implementation Schedule of Soft Component



(6) Documents to be Submitted

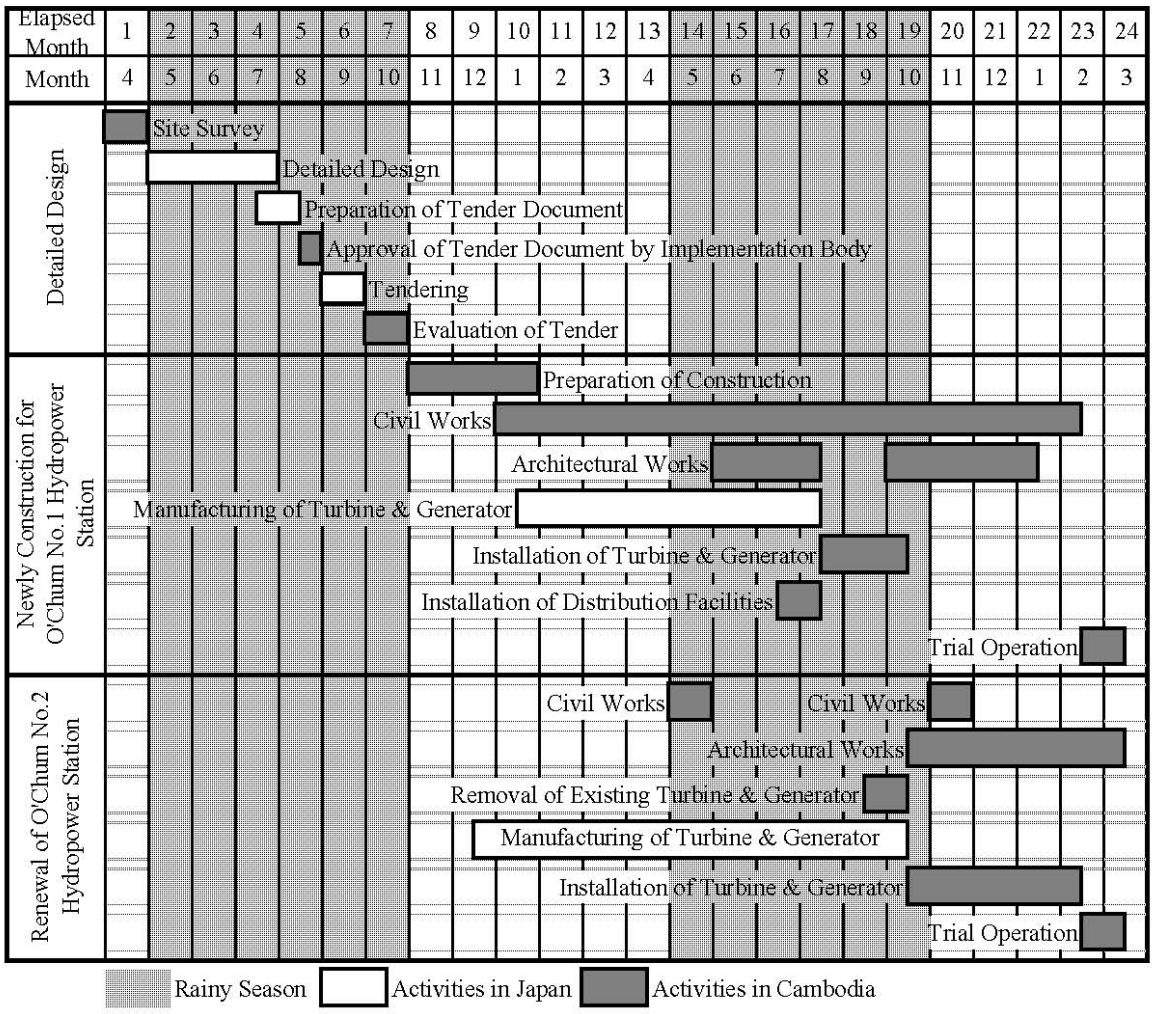
The following documents shall be submitted to JICA as outcome of the soft component.

Title of Document(s)	Time to Be Submitted
Completion Report	After the completion of this project
Condition Report	After the completion of each activity on this soft component
Manual for Operation & Maintenance of Micro Hydropower Civil Facilities and Result of Examination	After the completion of this project
Manual for Operation & Maintenance for Micro Hydropower Station and Result of Examination	Ditto
Manual for Operation & Maintenance for Distribution Lines Power System and Result of Examination	Ditto

3.2.4.9 Implementation Schedule

Demarcation of this project between Japan and Cambodia is mentioned in “3.2.4.3 Scope of Works”. In this regard, time schedule of both detailed design and construction which are borne by Japanese side is shown as below:

Table 3.2.4.9-1 Project Schedule



As you know, O'Chum No.1 Power Station is the hydropower project to utilize a part of facilities of the existing O'Chum No.1 dam, so that execution of works in the reservoir is unavoidable. So, in case of delay of contract with a consultant, bidding procedure, etc., it may be impossible to finish works in the reservoir within dry season when the reservoir level comes down. Consequently, completion of this project will also get behind the schedule.

3.3 Obligations of Recipient Country

Cambodian government is requested to take necessary actions to the following matters in the implementation of this project. As for land acquisition, Study Team supposes that the implementation body doesn't have to newly acquire land for this project since both O'Chum No.1 and No.2 Power Stations exist in EDC's land.

a. Securement of land for this project、acquisition of approval and permission to be required for implementation of the work, if necessary.
b. Maintenance of road outside of the construction site including safety facilities such as fence,

curve mirror, etc.

c. Expansion of distribution line outside the construction area, if necessary
d. Smooth custom clearance and remission of custom duty including surcharge
e. Remission of inland duty including surcharge which are necessary to pay in procurement of material, equipment, etc., for the project
f. Approval and permission to stay and enter in Cambodia for all of persons who supply consultancy service, material, equipment, etc. for this project,
g. Opening a bank account under the name of the Cambodian government in a bank in Japan
h. Cost burden of commission for an advising commission of an authorization to pay and payment to consultant and contractor
i. Care for people who are affected by this project
j. All of things required for implementation of the project which isn't covered in the grant agreement

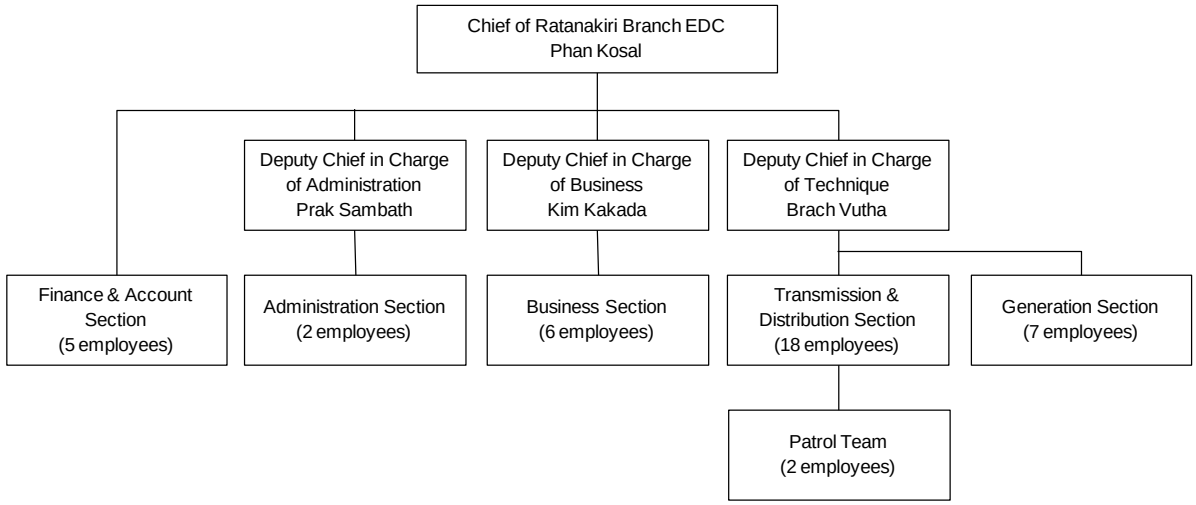
3.4 Project Operation Plan

3.4.1 Basic Policy

EDC, who implements this project, is the only public corporation in the electric field in Cambodia and shoulders power generation and transmission in Cambodia. Regarding hydropower generation, EDC has three power stations at present; O'Chum No.2 Power Station in Rattanakiri province managed by EDC Rattanakiri and O'Moleng & O'Romis hydropower stations in Mondul Kiri province managed by EDC Mondul Kiri. O'Chum No.1 Power Station which is newly constructed in this project is programmed to be managed by EDC Rattanakiri in addition to renewed O'Chum No.2 Power Station. Technical department in EDC Rattanakiri has two sections; one is transmission & distribution section where twenty employees work, and another is generation section where seven employees work. Needless to say, in is indispensable to increase operation staff for power stations due to new construction of O'Chum No.2 Power Station. Moreover, it is essential to improve technical capabilities of employees including those who have been employed for the purpose of effective operations of O'Chum No.1 & O'Chum No.2 power stations arranged stepwise. The improvement of technical capabilities is carried out by means of aforementioned soft component.

3.4.2 Organization for Management

O'Chum No.1 & No.2 power stations are planned to be managed by EDC Rattanakiri. Forty four employees belong to EDC Rattanakiri at present. Its organization is composed of finance & accounting section, administrative department, business department and engineering department. And, engineering department is divided into two sections; one is transmission & distribution section, and another is generation section.



（Source：EDCRattanakiri）

Figure 3.4.2-1 Organization Chart of EDC Rattanakiri (2012)

Working hour of ordinary staff in EDC is from 7:30 to 17:00 including lunch break. On the other hand, O'Chum No.2 hydropower station runs three shifts; 7:30 to 15:30, 15:30 to 23:30 and 23:30 to 7:30. As explained later, O'Chum No.1 Power Station is remotely operated from O'Chum No.2 Power Station, so that the above three shifts are unchanged.

3.4.3 Plan for Operation and Maintenance of Power Stations

3.4.3.1 Organization for Operation of Power Stations

As stated above, seven employees belong to generation section. Four employees work with ordinary day shift, and three employees work under the condition of three shifts. That is to say, operation of the existing O'Chum No.2 Power Station is done by only one employee. On the other hand, hydropower facilities are beefed up due to new construction of O'Chum No.1 Power Station and renewal of O'Chum No.2 Power Station. As a result, items to be managed also increase and these power stations will produce electricity year-round. Considered such situations, it is preferable to operate power stations by two operators all the time. In other word, it is suggested that total number of staff in the generation section becomes ten. In addition, we think it appropriate that one mechanical engineer who passes through electric engineering is assigned in this section at least.

On the other hand, it is hard to say that civil structures are well maintained. In order to operate and maintain these power stations, it is required to set up a new department to maintain civil structures. A responsible person shall be assigned to this new department, and this department is requested to consistently inspect whether something is wrong in civil structures such as dam, land around reservoir, intake, waterway, superstructure of powerhouse, etc.

As for transmission & distribution, the number of the staff will increase in accordance with extension of distribution line as appropriate.

3.4.3.2 Control of Power Stations

Both newly-constructed O'Chum No.1 Power Station and renewed O'Chum No.2 Power Station are planned to automate most of their operations in difference from the existing O'Chum No.2 Power Station. In addition, O'Chum No.1 Power Station is planned to be remotely operated from O'Chum No.2 Power Station, and reservoirs' water levels and data measured in the new gauging station are also planned to be transmitted to O'Chum No.2 Power Station. In order to manage the new operating system, the aforementioned soft component is aiming at capacity building through training for operation and maintenance of civil, electro mechanical, electrical and distribution.

3.4.3.3 Maintenance for Power Stations

Any regular maintenance and overhaul hasn't been carried out in O'Chum No.2 Power Station since 1993 when this hydropower station started producing electricity. Under the present circumstance, damaged portion is repaired every each time trouble happens. The cause to decrease output of O'Chum No.2 Power Station is supposed to be no periodic inspection and overhaul in addition to aged deterioration. In general, electro mechanical equipment is inspected in detail ever two years and overhauled every twelve or thirteen years in addition to dairy inspection in Japan. Regular inspection and overhaul will bring stable power generation for a long time.

As for preventive maintenance, it is important to prepare the "Medium and Long Term Plan for Power Station by EDC" The inspection plan must be executed in periodic providing maintenance budget and staff according to the long term plan about 5 to 10 years.

The Consultant will guide about the management of civil, electrical and distribution portions for new facilities to the EDC staff, and also to advice about as-built-drawing and documents as well as instruction manuals provided by the Contractor. Its technology transfer will reflect in the "Maintenance and Operation Manual for Rattanakiri"

It is better to hand all Rattanakiri staff on the results of soft component which is important to improve the operation and maintenance technique.

3.5 Cost Estimation

3.5.1 Project Cost Estimation

(1) Fiscal Year

This project is implemented in accordance with the Japan's grant aid scheme of single fiscal year. Thus, the project is commenced after Grant Agreement and procurement/installation work shall be completed with 24 months.(from March 2013 to February 2015)

(2) Project Cost

(a) Expenses to be Borne by the Japanese Side

Table 3.5.1-1 Project Cost

Work		One million yen	Note
Total Coctruction Cost			Civil, architecture, distribution line
	Direct Cost		
	Common temporary cost		
	Local administrative expenses		
	General/administrative expenses		
Electric equipment cost			Turbine, generator etc.
	Electrical equipment		Including transportation cost
	Procurement, installation work		
	General/administrative expenses		
Design management cost(consultant)			
	Civil		
	Electrical equipment		
	Soft component		
Total			

(b) Expenses to be Borne by the Cambodian Side

1) The amount to be borne by the Cambodian side will be minor and limited, as the O'Chum No.1 Power Station will be constructed and the O'Chum No.2 Power Station renewed by utilizing existing facilities and equipment within the land of EDC. The main expenditures of the Cambodian side will include exemptions of duties, domestic taxes, and other levies on the purchase of equipment and provision of services; fees needed for Advice of Credit associated with Authorization to Pay issued at the time of payment to Japanese contractors; banking fees, and O&M cost of the roads outside the Project site if necessary. More specifically, about one million yen will be needed as banking arrangement fees.

3.5.2 Operations and Maintenance Cost

The O'Chum No.1 and No.2 Power Stations are operated and maintained by the personnel of EDC Rattanakiri Office, which, as mentioned earlier, is headed by the Director and staffed by 44 employees on a fulltime basis. In its technical division headed by the Deputy Director, 20 technicians are assigned to the transmission/distribution department, and 7 to the power generation department, which is responsible for the operation and maintenance of the existing O'Chum No.2 Power Station. These technical staff members are not engineers graduated from science courses, but are mostly technicians, who received education on the operation and maintenance of power-transmission/distribution/generation equipment. Engineers of EDC's head office provide support when there is a technical problem, and this support system will be maintained and expanded after the construction of the O'Chum No.1 Power Station.

Unlike the existing O'Chum No.2 Power Station, the operations of the newly constructed O'Chum No.1 Power Station and the renewed O'Chum No.2 Power Station will mostly be automated. The O'Chum No.1 Power Station will be unmanned and remotely operated from the O'Chum No.2 Power Station. In addition, a new system will be built to enable the monitoring of reservoir levels and other observation data of the gauging station from the O'Chum No.2 Power Station to facilitate the efficient operation of reservoirs. Operating multiple power stations, which will be situated on a stair-stepped terrain for effective use of water, will be the first experience for the operators of the EDC Rattanakiri Office. For this reason, we plan to enhance the technical capabilities of the staff by conducting a capacity building program listed in the "Annex-5, Soft Component Plan."

Even though the No.1 Plant will be remotely controlled from the O'Chum No.2 Power Station, some additional operators will be needed. As indicated by the field surveys, the civil engineering structures have not been maintained properly, and a new department will need to be established to properly manage the dams, reservoirs and surrounding areas, water intake equipment, canals, power plant buildings, and other facilities. The transmission/distribution department will likely hire additional staff along with the expansion of the distribution network in the future.

Since its first operation in 1993, the O'Chum No.2 Power Station has not been maintaining its equipment and facilities in a systematic manner, but rather has dealt with each failure as it occurred. In equipment/facility maintenance, it is important to carry out periodic inspections and properly care for the equipment/facilities before they break. In Japan, such inspections are usually entrusted to outside contractors, and the cost therefore is generally high. In Cambodia, where maintenance work is performed by in-house engineers and technicians, the cost will be about half of that in Japan. Therefore, we estimated the cost of daily inspection at around 1% of the total equipment cost, that of biennial detailed inspection at 2%, and that of once-in-every-13-years overhaul at around 10%.

As mentioned earlier, each EDC office is not financially independent. Needless to say, however, it is desirable that the EDC Rattanakiri Office will independently pay for the maintenance cost of its two power plants using the revenue from the sales of electricity. We estimated the revenue and expenditure

of the O'Chum No.1 and No.2 Power Stations after the construction and renewal work, the result of which is shown in Table 3.5.2-1 below.

Table 3.5.2-1 Projected Revenue and Expenditure of O'Chum No.1 and No.2 Power Stations

		Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Revenue from sales of electric power	US$	**19,758**	**18,619**	**22,354**	**33,501**	**83,389**	**83,571**	**103,602**	**105,956**	**103,283**	**65,924**	**24,481**	**21,595**	**686,032**
O'Chum No.1 Power Plant	MWh	32.9	28.2	28	27.1	84.5	82.6	97.6	113.1	117.4	86.4	37	35.8	771
O'Chum No.2 Power Plant	MWh	97.2	94.4	119.2	193.5	464.6	467.7	584.6	584.6	562.7	347.7	124.2	106.4	3,747
Expenditure	US$	**9,741**	**9,736**	**9,750**	**9,792**	**9,978**	**9,979**	**10,054**	**10,063**	**10,053**	**9,913**	**9,758**	**9,747**	**118,564**
O'Chum No.1 Power Plant	US$	2,769	2,766	2,766	2,765	2,798	2,797	2,805	2,814	2,817	2,799	2,771	2,770	33,437
Cost for regular inspections	US$	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	12,000
Reserve for detailed inspections	US$	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	12,000
Reserve for overhaul	US$	750	750	750	750	750	750	750	750	750	750	750	750	9,000
License fees	US$	19	16	16	15	48	47	55	64	67	49	21	20	437
O'Chum No.2 Power Plant	US$	6,972	6,970	6,984	7,026	7,180	7,182	7,248	7,248	7,236	7,114	6,987	6,977	85,126
Cost for regular inspections	US$	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	30,000
Reserve for detailed inspections	US$	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserve for overhaul	US$	1,917	1,917	1,917	1,917	1,917	1,917	1,917	1,917	1,917	1,917	1,917	1,917	23,000
License fees	US$	0	0	0	0	0	0	0	0	0	0	0	0	0
Balance (Revenue – Expenditure)	US$	**10,017**	**8,882**	**12,604**	**23,709**	**73,410**	**73,592**	**93,548**	**95,893**	**93,230**	**56,011**	**14,722**	**11,848**	**567,469**

The parameters of the above estimation are as follows.

<Revenue（same for O'Chum No.1 and No.2 Power Stations）>

Unit price of electricity	165.3 US$/MWh	According to EAC 2011 Annual Report, the average unit price of electricity in Cambodia is 670KRH/kW, which is 0.1653US$/kWh at the conversion rate of 1US$ = 4,052.6KHR (average of past 10 years).
Internal consumption rate	1%	
Distribution loss	7.2%	Actual record of 2011

<Expenditure>

Item	O'Chum No.1	O'Chum No.2	Inspection frequency, etc.
Regular inspection	12,000US$/yr	30,000US$/yr	Daily
Detailed inspection	12,000US$/yr	30,000US$/yr	Once in every 2 years or so
Overhaul	9,000US$/yr	23,000US$/yr	Once in every 13 years
License fees	0.0006US$/kWh	0.0006US$/kWh	Power generation / transmission / distribution: 2.3KHR/kWh (source: EAC 2011 Annual report) (=0.0006US$/kWh at 1US$ = 4,052.6KHR)

According to the above estimation, this Project will be in the black throughout the year, and the O&M cost will be covered by income from the sales of electricity[15].

[15] It should be noted that the above estimation does not correspond to the projected balance of revenue and expenditure of EDC's Rattanakiri Office, as it has other expenses, including the purchase of imported electricity from Vietnam and associated maintenance cost and depreciation of capital investment.

4. Project Evaluation

4.1 Preconditions of Project Implementation

Listed below are the preconditions for the implementation of this Project.

(1) In commencing the detail design, it will be necessary to study the integrity and dimensions of the existing box culverts and intake gates, including doorstops, inside the dam body, into which penstocks will be inserted, and reflect the results into the design. For this reason, it is necessary to lower the reservoir level of the O'Chum No.1 Dam completely in time for the field survey to be carried out prior to the detail design.

(2) The construction of the O'Chum No.1 Power Station, which will be using part of the existing No.1 Dam to generate power, will include work inside the reservoir, which needs to be done during the dry season between November and April when the precipitation and the reservoir level are low. Therefore, it is important to drain the reservoir in a well-planned manner by taking into account the status of rainfall.

(3) As the O'Chum No.2 Power Station will stop operation for about six month during the renewal work, alternative power sources need to be secured for this period.

4.2 Input (Responsibility) of the Recipient Side for the Achievement of the Overall Plan

In order to achieve the overall plan of the Project, the recipient side needs to undertake the following.

(1) Provide appropriate compensation and take other necessary measures in accordance with the guidelines of JICA in order to secure the livelihood of the residents, who will need to be resettled as a result of implementing this Project. In addition, respond to the claims of the affected residents in an appropriate manner.

(2) Employ additional operators in order to properly operate and maintain the O'Chum No.1 and No.2 Power Stations. Also, the civil engineering facilities maintenance department should be newly established for their proper operation and maintenance.

(3) Create reserve funds to cover the cost of daily inspection, biennial detail inspection, and once-in-every-13-years overhaul.

4.3 External Condition

In estimating the expenses to be incurred associated with this Project, we used the currency exchange rate of 1US$ = 81.06JPN, which is an monthly average TTS for the 6-month period (February – July, 2012) beginning at the end of July 2012, which is the month preceding our return from the field survey. However, as of the end of January 2013, the value of one US dollar is about to exceed 91 yen, which could affect the subsequent detail design and bidding, and therefore needs to be watched carefully.

4.4 Evaluation of the Project

4.4.1 Appropriateness

This Project is to be implemented in Rattanakiri, one of the high poverty rate Provinces in Cambodia, where reliable electricity supplies are urgently needed to improve the living standards of the region. The poverty rate of Cambodia as a whole is 35.13% while that of seven rural provinces, including Rattanakiri, is as high as 46.11%[16]. On the other hand, Rattanakiri holds a great potential for small hydropower development to generate renewable energy by taking advantage of its mountainous topography and abundant water resources. Small hydropower stations have a relatively minor impact on the environment and society, and can be constructed in a relatively short period of time. Also, this Project is consistent with and appropriate for the Cambodia's mid- to long-term national development plan (National Strategic Development Plan 2009-2013), which gives priority to the expansion of power supply capacities, as well as the Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia, which aims to utilize domestic resources and renewable energy.

4.4.2 Effectiveness

4.4.2.1 Quantitative Effects

Shown below are the indices for measuring the quantitative effects of this Project and the targets to be achieved after its implementation.

Table 4.4.2.1-1 Quantitative Effects Expected from the Implementation of the Project

Indices	Baseline	Target (2018) [3 yrs. after completion of Project]
Maximum output (kW)		
1. O'Chum No.1 Power Station	0	265
2. O'Chum No.2 Power Station	820	960
Operating rate (%)		
1. O'Chum No.1 Power Station	0	34
2. O'Chum No.2 Power Station	31	45
Generation-end output (MWh/yr)		
1. O'Chum No.1 Power Station	0	771
2. O'Chum No.2 Power Station	2,620*[1]	3,747
Reduction of CO_2 emission (t/yr) *[2]		
1. O'Chum No.1 Power Station	0	315.3
2. O'Chum No.2 Power Station	1,071.5	1,532.5

*[1] An average annual output of the O'Chum No.2 Power Station of the past 6 years.

*[2] Volume of CO_2 emission reduced: Actual output from O'Chum No.1 and No.2 Power Station (increased volume) × emission coefficient of Vietnam (generating end)[17] (409 kg CO_2 / MWh)

[16] A poverty Profile of Cambodia 2004 Ministry of Planning 2006

[17] IEA Statistics CO_2 EMISSIONS FROM FUEL COMBUSTION (2011 edition), CO_2 emissions per kWh from electricity and heat generation, average between 2007 and 2009. Emission coefficient of Vietnam is used in lieu of electricity imported from Vietnam

4.4.2.2 Qualitative Effects

Implementation of this Project is expected to generate the following qualitative effects:

1) Diversification of Power Sources in Cambodia

   By fortifying its power generating capacity based on domestic resources while accepting import from other countries, Cambodia will be able to increase its energy security.

2) Dissemination and Promotion of Small Hydro Development in Cambodia

   Construction and efficient operation of small hydropower stations in Rattanakiri Province in succession to the ones built in Mondulkiri Province under Japan's grant aid will facilitate the dissemination and development of small hydropower projects in Cambodia.

3) Acquisition of Know-How for the Operation of Reservoirs & Hydropower Plants

   The operation of the existing O'Chum No.2 Power Station has been relying on the experience and intuition of the operators without any documentation necessary for proper operations/maintenance. Conducting an appropriate training program following the equipment renewal will enable the operators to acquire the know-how for managing hydropower plants.

Appendix–1

JICA Study Team Members

（Site survey, August 2012）

NAME	ASSIGNMENT	BELONG
NIWA AKIRA	Leader	Senior Advisor, JICA
NAITO TAKESHI	Project Coordinator	Electric Power Division, Natural Resources and Energy Group, Industrial Development and Public Policy Dept. JICA
KATO KENJI	Chief Consultant / Planning of O&M/development plan	Electric Power Development Co., Ltd.
TSUCHIYA EIJI	Electrical/Mechanical/ protection/control	Electric Power Development Co., Ltd.
SASA MAMORU	Civil design	Electric Power Development Co., Ltd.
OGAWA HIROSHI	Environment/social consideration	Smart Energy Co., Ltd
UCHIYAMA YUKIKO	Economic/financial analysis	Japan Economic Research Institute Inc.
SHINOHARA JUNYA	Power system planning	The Chugoku Electric Power Co., Inc.
IHARA HIDENORI	Procurement of material/cost estimator-1	Chuden Engineering Consultants Co., Ltd.
HAYAMO TORU	Procurement of material/cost estimator-2	Chuden Engineering Consultants Co., Ltd.
SARUWATARI YUJI	Topographical survey-1	Chuden Engineering Consultants Co., Ltd.
MOTOYASU TSUTOMU	Topographical survey-2	Chuden Engineering Consultants Co., Ltd.

（Explanation of draft final report, December, 2012）

NAME	ASSIGNMENT	BELONG
NAITO TAKESHI	Project Coordinator	Electric Power Division, Natural Resources and Energy Group, Industrial Development and Public Policy Dept. JICA
KATO KENJI	Chief Consultant / Planning of O&M/development plan	Electric Power Development Co., Ltd.
TSUCHIYA EIJI	Electrical/Mechanical/ protection/control	Electric Power Development Co., Ltd.
OGAWA HIROSHI	Environment/social consideration	Smart Energy Co., Ltd
SHINOHARA JUNYA	Power system planning	The Chugoku Electric Power Co., Inc.

Appendix–2

Itinerary

(Site survey, August 2012)

			JICA	Consultant									
No	Date		Niwa Akira Naito Takeshi	KATO KENJI Chief Consultant／Planning of O&M/development plan	TSUCHIYA EIJI Electrical/Mechanical/ protection/control	SASA MAMORU Civil design	OGAWA HIROSHI Environment/social consideration	UCHIYAMA YUKIKO Economic/financial analysis	IHARA HIDENORI Procurement of material/cost estimator-1	HAYAMO TORU Procurement of material/cost estimator-2	SHINOHARA JUNYA Power system planning	SARUWATARI YUJI Topographical survey-1	MOTOYASU TSUTOMU Topographical survey-2
1	July 29	Sun		NRT12:00→PHN19:25					KIX11:45→PNH19：25				
2	July 30	Mon		AM JICA Office, PM EDC									
3	July 31	Tue		Meeting with EDC							To Ratanakiri		
4	August 1	Wed		To Ratanakiri							AM Meeting with EDC PM Site Investigation		
5	August 2	Thu	NRT11:00→ BKK15:30（TG641） BKK18:15→ PHN19:25（TG584）	AM EDC Ratanakiri PM Site Investigation							Site Investigation		
6	August 3	Fri	AM JICA Office PM EDC・MIME	Site Investigation									
7	August 4	Sat	To Ratanakiri	Site Investigation	To Phnom Penh	Site Investigation		To Phnom Penh	Site Investigation				
8	August 5	Sun	Meeting	Site Investigation									
9	August 6	Mon	AM Discussion with EDC Ratanakiri PM Site Investigation		Discussion with EDC, Data Collection and Review	Site Investigation		Discussion with EDC, Data Collection and Review	Site Investigation				
10	August 7	Tue	To Phnom Penh			To Phnom Penh			To Phnom Penh			Site Investigation	
11	August 8	Wed	Discussion with EDC(M/D),MEF										
12	August 9	Thu	AM Report to Japanese Embassy PM Discussion with EDC(signature）、Report to JICA Office										
13	August 10	Fri	PHN10:05→ BKK11:10（TG581） BKK14:20→ HND22:30（TG660）	Discussion with EDC, Data Collection and Review			PHN20:25→		Discussion with EDC, Data Collection and Review		PHN20:25→		
14	August 11	Sat					NRT08:10				KIX7:00		
15	August 12	Sun											
16	August 13	Mon											
17	August 14	Tue											
18	August 15	Wed											
19	August 16	Thu											
20	August 17	Fri											
21	August 18	Sat											
22	August 19	Sun											
23	August 20	Mon											
24	August 21	Tue											
25	August 22	Wed											
26	August 23	Thu											
27	August 24	Fri											
28	August 25	Sat											
29	August 26	Sun		PHN20:25→					PHN20:25→			PHN20:25→	
30	August 27	Mon		NRT08:10	PHN10:05→HND22:30				KIX7:00			KIX7:00	

（Explanation of draft final report, December, 2012）

	Date	Week	JICA(Naito Takeshi)	Consultant(Kato, Tsuchiya, Ogawa, Shinohara)
1	Dec.9	Sun.		NRT→PNH
2	Dec.10	Mon.		Data collection and meeting
3	Dec.11	Tue.		Data collection and meeting
4	Dec.12	Thu.		Meeting with EDC
5	Dec.13	Wed.		Phnom Penh→Rattanakiri
6	Dec.14	Fri.		Meeitng with EDC Rattanakiri Stakeholder meeting
7	Dec.15	Sat.		Site Survey
8	Dec.16	Sun.	NRT11:45→BKK16:45 TG643 BKK18:25→PNH19:40 TG584	Site Survey
9	Dec.17	Mon.	Meeting and data collection	Rattanakiri→Phnom Penh
10	Dec.18	Tue.	Meeting and data collection Meeting with JICA Cambodia Office	Discussion with EDC Meeting with JICA Cambodia Office
11	Dec.19	Thu.	AM: Discussion with EDC PM :Meeting with Japanese Embassy	
12	Dec.20	Wed.	Meeting and data collection PM :Meeting with JICA Cambodia Office	Modification work of draft final report PM :Meeting with JICA Cambodia Office
13	Dec.21	Fri.	Meeting and data collection PNH20:40→BKK21:45 TG585 BKK23:50→	Modification work of draft final report PNH20:40→BKK21:45 TG585 BKK23:50→
14	Dec.22	Sat.	→NRT07:30 TG642	→NRT07:30 TG642

Appendix–3

Main Attendants of Meeting

(1) Ministry of Industry, Mines and Energy

Dr. Bun Narith	Deputy Director General
Mr. Pan Narith	Hydroelectricity Department, Chief Hydroelectricity Project
Mr. Ngeth Bora	Hydroelectricity Department, Hydroelectricity Planning Office

(2) Ministry of Environment

Dr. Oum Pisey	Director, Department of Planning & Legal Affairs
Mr. Sekkheng Novin	Director, Nature Conservation & Protection
Mr. Ou Sophorn	Vice chief, Department of EIA Review
Mr. Sok Sopheaktra	Officer, Department of EIA Review
Mr. Sok Pounlork	Officer, Department of EIA Review
Mr. Puth Sority	Director, EIA Dept. & Representative of MOE in CDC

(3) Ministry of Environment (Rattanakiri)

Mr. Chou Sophark	Director of Virachay National Park

(4) Council Office of Banlung

Mr. Somnang	Deputy Director of Council Office

(5) Thrang Chong Village

Mr. Sreung Kasem	Deputy Village Chief, Thrang chong Village
Mr. Sreung Uuthy	Villager

(6) Ministry of Planning

Mr. Long Chintha	Deputy Director General)
Dr. Phim Sopheap	National Planning System Advisor

(7) EAC

Mr. Yem Viseth	Director, Supply and Consumer Affairs Department
Mr. Nong Rithya	Manager, Supply Office
Mr. Ly Channarey	Manager of Tariff office

(8) EDC Phnom Penh

Mr. Keo Rottanak	RGC Delegate in charge of Managing EDC Advisor to Prime Minister
Mr. Chan Sodavath	Deputy Managing Director of Technique
Mr. Eng Kunthea	Deputy Managing Director of Admnistration
Mr. Ros Chenda	Director of Generation Department
Mr. Aun Hemrith	Deputy Director of Generation Department

Mr. Chun Piseth	Deputy Director, Corporate Planning & Projects Department
Mr. Minh Davann	Deputy Director, Generation Department
Mr. Pen Pha	Chief of Technical Office, Generation Department
Mr. Mao Visal	Chief Office, Social, Environmental and Public Relation
Mr. Mok Phoumy	Deputy Chief, Technical Office, Corporate Planning & Projects Department
Ms. Ngin Kanida	Deputy Chief, Planning Management Information System and Tariff Office, Corporate Planning & Projects Department
Mr. Heng Piseth	Deputy Chief of Technical Office, Generation Department
Mr. Eang Chanthy	Chief of Section, Technical Office, Generation Department
Mr. Chea Samol	Deputy Chief of Distribution Network Unit, Business & Distribution Department
Mr. Eang Chanthy	Chief of Section, Technical Office, Generation Department
Ms. Van Lida	Chief, Corporate Finance Office, Finance & Accounting Department

(9) EDC Rattanakiri

Mr. Phan Kosal	Chief of Electricity of Rattanakiri
Mr. Prak Sambath	Deputy Chief of Electricity of Rattanakiri

(10) Japanese Embassy

Katsuo Yoshihito	First Secretary
Tamamitsu Shinichi	First Secretary

(11) JICA Cambodia Office

Suzuki Yasujiro	Chief Representative
Hirata Hitoshi	Senior Representative
Shinoda Takanobu	Representative
Yokoi Hiroyuki	Representative

Appendix–4 Minutes of Discussion（Site survey, August 2012),
(Explanation of draft final report, December, 2012)

Appendix–5 Soft Component (Technical Assistance) Plan

Appendix–6 Drawings (DWG No. 1-No.13)

Appendix–7 Environmental Check list

Appendix–8 Monitoring form

Appendix–9 Letter of indemnity delivery

Appendix–10 Minutes of stakeholder meeting and attendance list

Appendix-4

Minutes of Discussion
（Site survey, August 2012），
（Explanation of draft final report, December, 2012）

Minutes of Discussions
on the Preparatory Survey on the Project for
Micro Hydropower Development in the Rattanakiri Province, Kingdom of Cambodia

In response to the request from the Royal Government of Cambodia (hereinafter referred to as "RGC"), the Japan International Cooperation Agency (hereinafter referred to as "JICA"), in consultation with the Government of Japan (hereinafter referred to as "GOJ"), decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") on the Project for Micro Hydropower Development in the Rattanakiri Province (hereinafter referred to as "the Project").

JICA dispatched the Preparatory Survey Team (hereinafter referred to as "the Team") to Cambodia, headed by Dr. Akira NIWA, Senior Advisor, Department of Human Resources for International Cooperation, JICA. The Team is scheduled to stay in Cambodia from July 30 to August 26, 2012.

The Team held discussions with the officials of concerned authorities in Cambodia (hereinafter referred to as "the Cambodia side"), and conducted a series of field survey. In the course of the discussions, both the Cambodia side and the Team (hereinafter referred to as "Both sides") have confirmed the main items described in the sheets attached hereto.

Phnom Penh, August 9th, 2012

Akira NIWA
Leader, Preparatory Survey Team,
Japan International Cooperation Agency

Keo Rottanak
RGC Delegate in charge of Managing EDC,
Electricite Du Cambodge

Witness:

Ith Praing
Secretary of State,
Ministry of Industry, Mines and Energy

ATTACHMENT

1. Objective of the Project
To construct micro hydropower plant for promoting renewable energies in rural electricity supply.

2. Locations of Project
The project site is located in O'Chum District, Rattanakiri Province as shown in Annex-1.

3. Responsible and Implementing Organizations
(1) The responsible organization is General Department of Energy, Ministry of Industry, Mines and Energy (MIME).
(2) The implementing organization is Electricite Du Cambodge (EDC).

The Organization Structures of MIME and EDC are shown in respectively Annex-2 and Annex-3.

4. Components Confirmed by Both Sides
Confirmed components of the Project are as follows.
(1) Construction of micro hydropower plant
(2) Improvement and reinforcement works of the existing O'Chum No.1 dam to secure stable operation of new hydropower plant
(3) Power evacuation to the existing grid and optimization in power generation
(4) Training for O&M and provision of O&M manuals for O'Chum No.1 hydropower plant (Soft-Component)

The Cambodia side requested new transformers and switchgear to replace the old 10kV system at O'Chum 2 Hydropower plant. The team replied to assess the necessity and adequacy of the request in the survey. JICA will assess the appropriateness of the components for Japan's Grant Aid and report the findings to GOJ.

5. Japan's Grant Aid Scheme
(1) JICA confirmed that the Cambodia side understood Japan's Grant Aid Scheme explained by the Team as described in Annex-4 and 5.
(2) The Cambodia side will take the necessary measures, as described in Annex-6, for smooth implementation of the Project as prerequisites for the Japan's Grant Aid to be implemented.

6. Environmental and Social Considerations
(1) The Cambodia side agreed to comply with the JICA Guidelines for Environmental and Social Considerations (April, 2010) (hereinafter referred to as "JICA Guidelines") as well as laws and regulations in Cambodia, and was requested to prepare Environmental Checklist, Abbreviated Resettlement Plan and Monitoring Form which are designated by JICA Guidelines for an outline design.
(2) The Cambodia side agreed to make necessary arrangements with concerned governmental organizations concerned in order to secure funding for and execution of the above environmental matters in a schedule as required for smooth execution of the Project.
(3) The Cambodia side agreed to complete necessary procedures by December, 2012.

7. Schedule of the Survey
The team will continue with the Field Survey in Cambodia until 26th August, 2012 and report the

result to GOJ. Based on the results of the Survey, JICA will dispatch the team to Cambodia to explain the report of the Preparatory Survey in December, 2012.

8. Other Relevant Issues

(1) Status of the Survey

The Team explained that the purpose of the Survey is to collect information and data necessary for the outline design and cost estimation of the Project components which are confirmed through the Survey and the analysis in Japan.

(2) "Green Growth"

The Team explained that the Project will be conducted under the Japanese Grant Aid Program aiming at promoting "Green Growth", which the Government of Japan puts stress on, by introducing small scale hydropower plants with elaborated technologies of Japan.

(3) Coordination of responsible and implementing organization

The Cambodia side will take proper action to coordinate responsible and implementing organization.

(4) Drawing of existing facilities

The Cambodia side requested and the Team agreed to prepare the As-Built drawings of new hydropower plant and the re-drawing of associated civil parts of O'Chum No.1 Dam. The re-drawing will describe the outer dimension of the structure proportion and not include the detail of reinforcement. The format and scale of the drawing will be decided through the discussion at the detail design stage

(5) Dispatch counterpart personnel

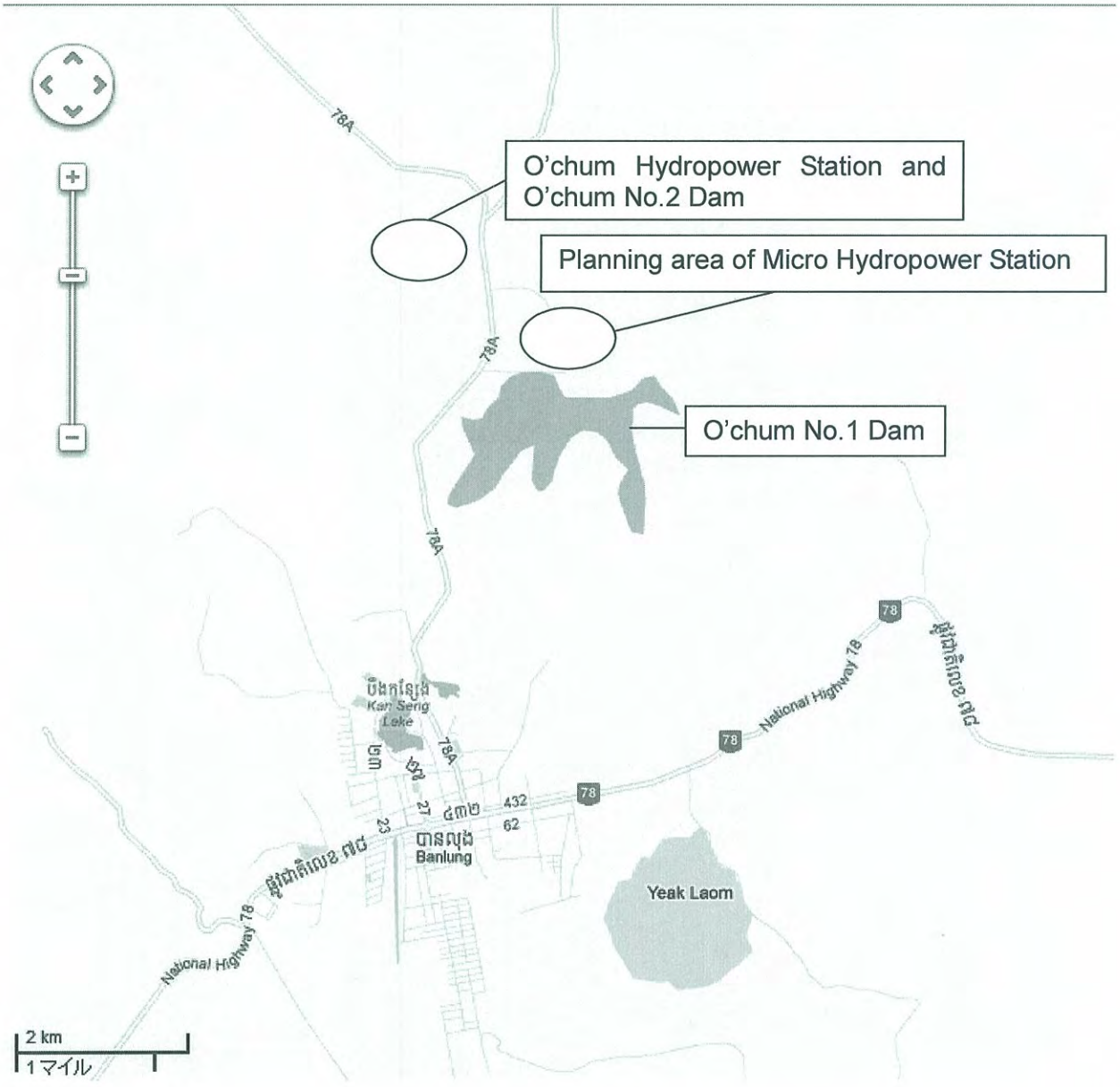
Both sides confirmed the need of dispatching counterpart personnel from the Cambodia side.

(End)

Annex-1	Project Site
Annex-2	Organization Chart of MIME
Annex-3	Organization Chart of EDC
Annex-4	Japan's Grant Aid
Annex-5	Flow Chart of Japan's Grant Aid Procedures
Annex-6	Major Undertakings to be taken by Each Government

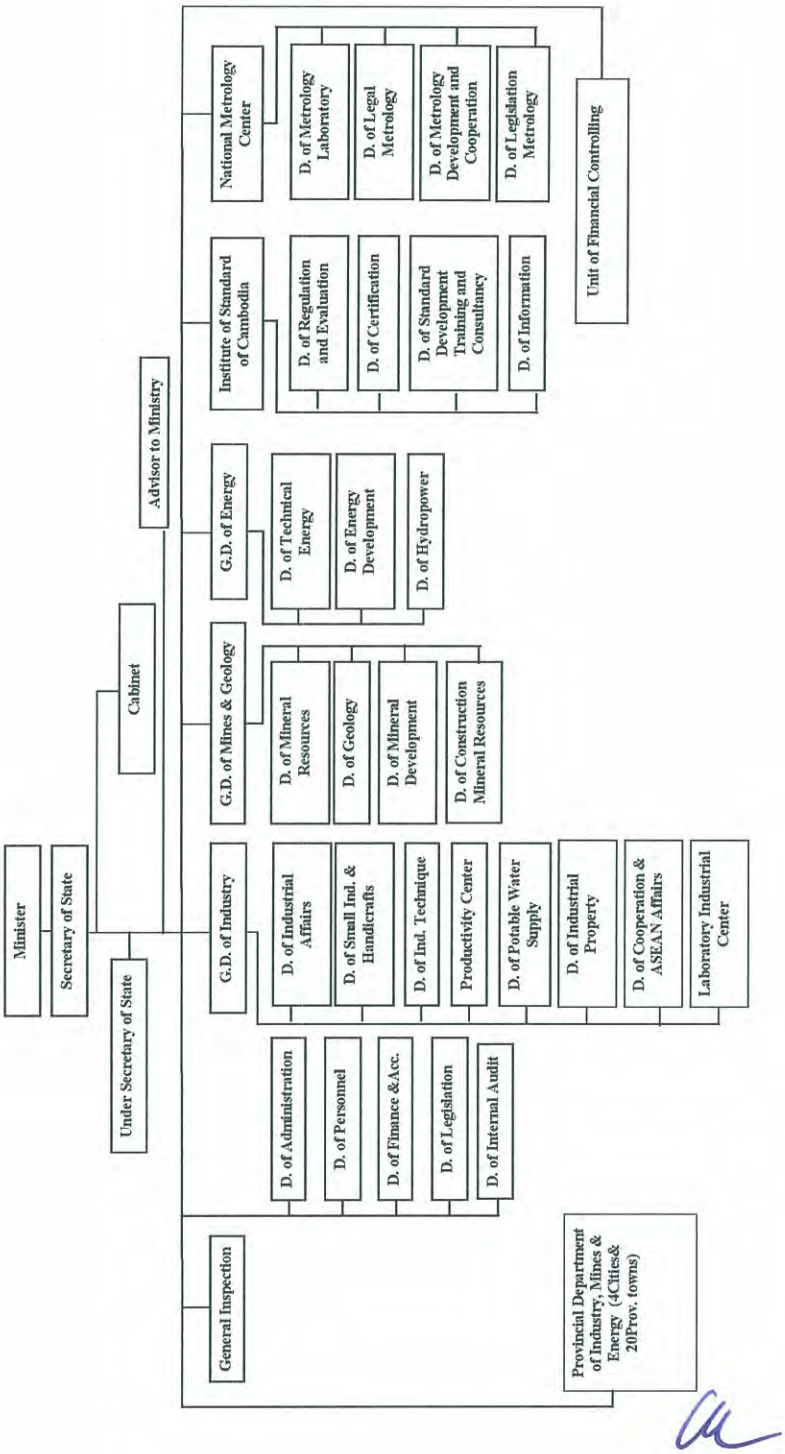
Annex 1

Project Site



Annex 2

Organization Chart of MIME

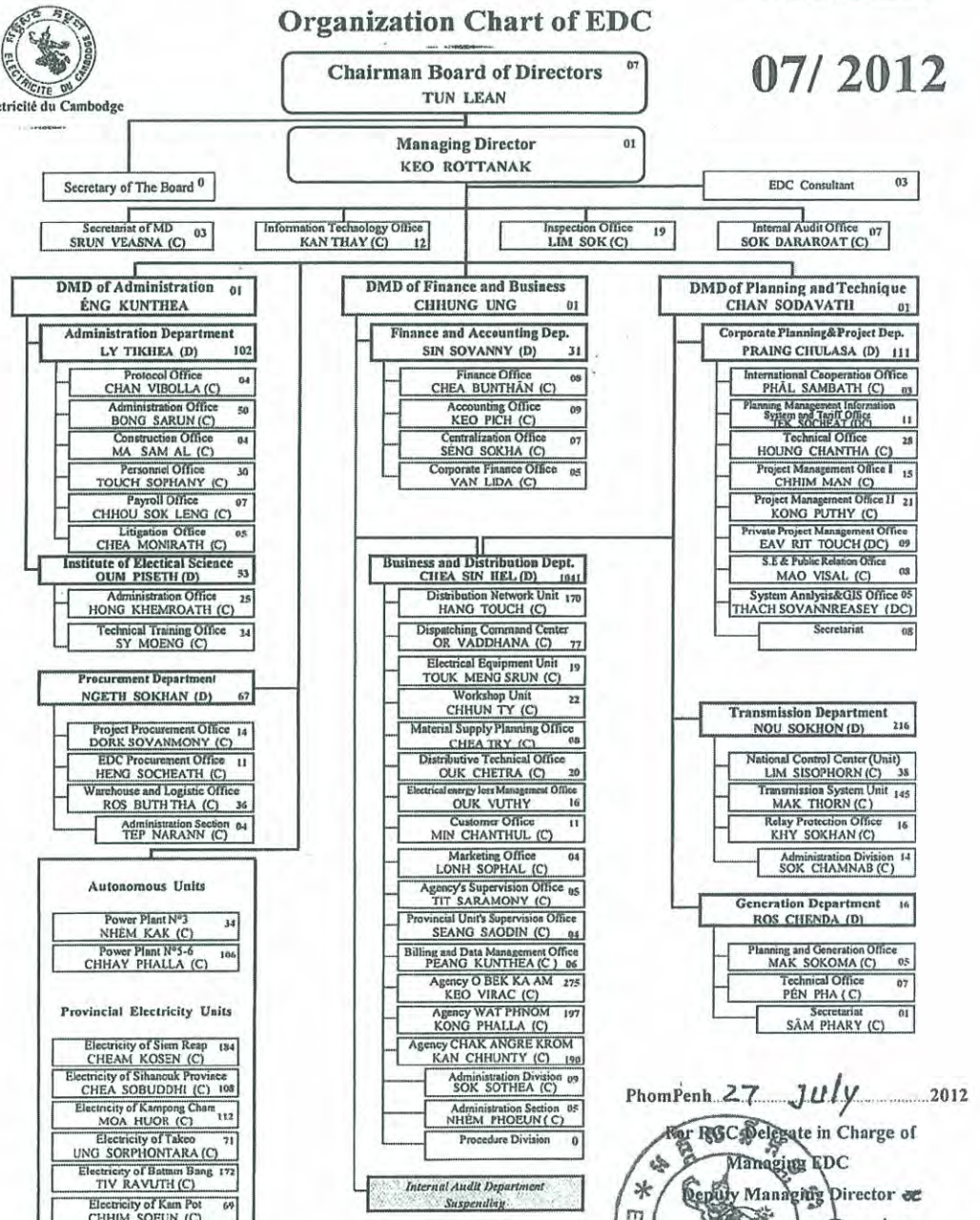


Annex 3

Electricité du Cambodge

Organization Chart of EDC

07/ 2012



Grand total	:	2931 P (07 / 2012)
Included :		
- Permanent staffs	:	2867 P (07 / 2012)
- Contractual staffs	:	64 P (07 / 2012)
Total EDC(Phom Penh)	:	1825 P (06 / 2012)
Included :		
- Non autonomous Units	:	1685 P
- Autonomous Units	:	140 P
Total EDC (Provinces)	:	1106 P (07 / 2012)

PhomPenh 27 July 2012

For RGC Delegate in Charge of
Managing EDC
Deputy Managing Director

ENG KUN THEA

JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

・Preparatory Survey
- The Survey conducted by JICA

・Appraisal &Approval
-Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet

・Authority for Determining Implementation
-The Notes exchanged between the GOJ and a recipient country

・Grant Agreement (hereinafter referred to as "the G/A")
-Agreement concluded between JICA and a recipient country

・Implementation
-Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of a basic design of the Project.

- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

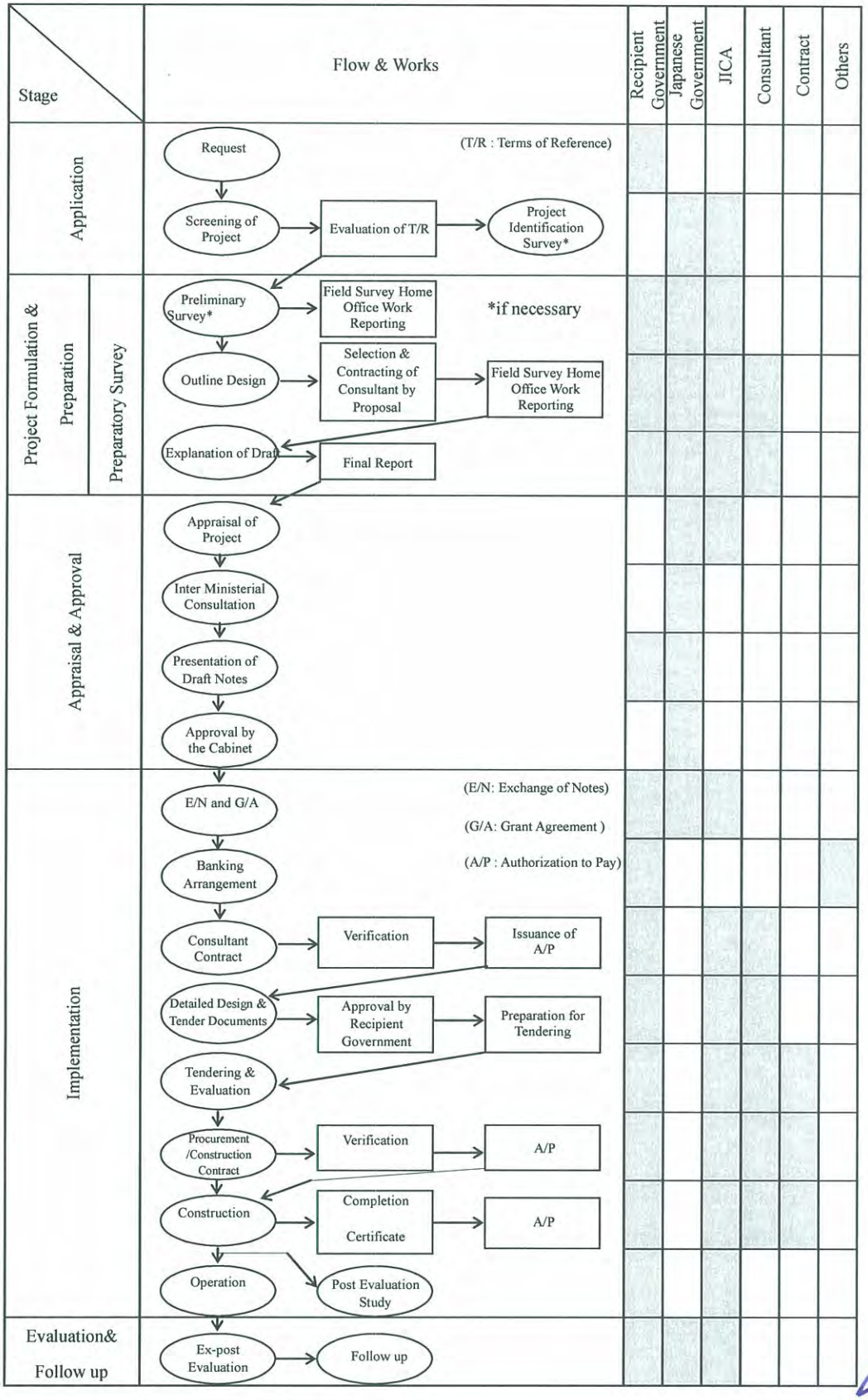
(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

(End)

Annex-5

Flow Chart of Japan's Grant Aid Procedures



Annex-6

Major undertakings to be taken by each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	to secure [a lot] /[lots] of land necessary for the implementation of the Project and to clear the [site]/[sites];		●
2	To construct the following facilities		
	1) The building	●	
	2) The gates and fences in and around the site		●
	3) The parking lot	●	
	4) The road within the site	●	
	5) The road outside the site		●
3	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the [site]/[sites]		
	1)Electricity		
	a. The distributing power line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the Products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services [be exempted] / [be borne by the Authority without using the Grant]		●
6	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To ensure that [the Facilities and the products]/[the Facilities]/ [the products] be maintained and used properly and effectively for the implementation of the Project		●
8	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		●
9	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
10	To give due environmental and social consideration in the implementation of the Project.		●

*1 B/A : Banking Arrangement, A/P : Authorization to pay) *2 If the environmental screening category is C, No. 10 is unnecessary

Minutes of Discussions on the Preparatory Survey of
The Project of Micro Hydropower Development in Rattanakiri Province,
Kingdom of Cambodia
(Explanation on Draft Final Report)

In response to the request from the Royal Government of Cambodia (hereinafter referred to as "RGC"), the Japan International Cooperation Agency (hereinafter referred to as "JICA"), in consultation with the Government of Japan (hereinafter referred to as "GOJ"), decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") on the Project of Micro Hydropower Development in Rattanakiri Province (hereinafter referred to as "the Project"). From July to August 2012, JICA dispatched the Survey Team to Cambodia; and through discussions, field surveys and the result of technical examination in Japan, JICA prepared a Draft Final Report of the Survey.

In order to explain and to consult with the officials of concerned authorities in Cambodia (hereinafter referred to as "Cambodia side") on the contents of the Draft Final Report, JICA dispatched to Cambodia the Preparatory Survey Team for Draft Final Report Explanation (hereinafter referred to as "the Team"), which is headed by Mr. Hitoshi HIRATA, senior representative of JICA Cambodia Office, from December 10th to 20th, 2012.

In the course of the discussions, the team and the Cambodia side (hereinafter referred to as "both sides") have confirmed the main items described in the sheets attached hereto.

Phnom Penh, December 19th, 2012

Hitoshi HIRATA
Senior Representative,
Cambodia Office,
Japan International Cooperation Agency (JICA)

Keo Rottanak
RGC Delegate in charge of Managing EDC
Electricite Du Cambodge

ATTACHMENT

1. Contents of the Draft Final Report

The Cambodia side agreed and accepted in principle the contents of the Draft Final Report and the Draft Technical Specifications of the Survey explained by the Team.

2. Responsible and Implementing Organizations

(1) The responsible organization is General Department of Energy, Ministry of Industry, Mining and Energy (MIME).

(2) The implementing organization is Electricite Du Cambodge (EDC).

The Organization Structures of MIME and EDC are shown in Annex-2 and Annex-3.

3. Components of the Project

The components of this project are as follows;

- Construction of micro-hydro power plant at the O'Chum No.1 Dam.
- Re-construction of existing facilities including an intake at the O'Chum No.1 Dam
- Construction of distribution line from the new hydro power plant at O'Chum No.1 Dam
- Replacement of facilities including turbines and generators in the O'Chum No2. Power Station
- Rehabilitation of the road for maintenance in the O'Chum No2. Power Station
- Soft Component (Technical Assistance)

4. Japan's Grant Aid Scheme

The Cambodia side reconfirmed the Japan's Grant Aid Scheme and the necessary measures to be taken by the Cambodia side explained by the Team as described in Annex-4 and Annex-5 respectively.

5. Project Cost

The Team explained the estimated cost of the Project as described in Annex-6. The Cambodia side agreed that the cost for the Project should not exceed the amount agreed on Exchange of Notes (E/N). The Cambodia side also agreed that the cost for the Project contains procurement cost of equipment, transportation cost up to the Project site, installation cost and the Consultant fees.

6. Confidentiality of the Project

(1) Detailed specifications of the Facilities and Equipment

Both sides agreed that all the information related to the Project including detailed drawings and specifications of the facilities and equipment and other technical information shall not be disclosed to any outside parties (i.e. outside of JICA and the Cambodia side) before the conclusion of all contract(s) for the Project.

(2) Confidentiality of the Cost Estimation

The Team explained the estimated cost of the Project as described in Annex-6. Both sides agreed that the estimated cost for the Project should never be duplicated or disclosed to any outside parties (i.e. outside of JICA and the Cambodia side) before tender for the Project. The Cambodia side understood that the estimated cost for the Project attached as Annex-6 is not

the final and is subject to change as a result of the detailed design to be implemented after the E/N.

7. Environmental and Social Considerations

(1) The Cambodia side agreed to comply with JICA Guidelines for Environmental and Social Considerations (April 2010) (hereinafter referred to as "JICA Guidelines") as well as laws and regulations in Cambodia.

(2) Both sides confirmed information on environmental and social considerations including major impacts and relevant mitigation measures are summarized in the Environmental Checklist attached as Annex-7. EDC confirmed they will inform JICA of any major changes which may affect environmental and social considerations made for the Project by revising the Checklist in a timely manner.

(3) Both sides confirmed environmental monitoring will be conducted by EDC in accordance with the Environmental Monitoring Plan described in the draft of Preparatory Survey Report.

(4) Both sides confirmed internal monitoring proposed in the livelihood restoration program will be conducted by EDC. EDC will report the monitoring results to JICA by filling in the Annex-8.
In case there is a remaining issue that needs to be addressed (e.g. insufficient restoration of livelihood of project affected people (hereinafter referred to as "PAPs"), JICA may request to extend the period of monitoring and reporting until JICA confirms the issues have been properly addressed and solved in accordance with the agreement between EDC and JICA.

(5) EDC confirmed it will take stipulated procedures for information disclosure in accordance with concerned regulations. In addition, the team requested EDC to disclose the monitoring results to local project stakeholders, and EDC agreed to disclose monitoring results in their field offices.

(6) EDC agreed JICA's disclosure of provided monitoring results in the monitoring form (Annex-8) on its website.

(7) EDC confirmed to Ministry of Environment that EDC does not have to conduct both Environmental Impact Assessment and Initial Environmental Impact Assessment for implementation of the Project in accordance with concerned regulations.

8. Possibility of Change in Scope, Schedule and Cost of the Project

The Team stressed that the scope, the schedule, and the cost for the Project are tentative and subject to change due to the domestic circumstances in Japan and in Cambodia. The Cambodia side understood it.

9. Other Relevant Issues

(1) Project title

Both sides agreed the project title is changed to "The Project for Construction and Rehabilitation of Small Hydro Power Plants in Rattanakiri Province".

(2) "Green Growth" policy

The Cambodia side recognized, as the Embassy of Japan explained, that the Project will be formulated and conducted in accordance with the "Green Growth" policy of the Government of Japan, which emphasizes on utilizing the major equipment such as hydro turbines made by

Japan's small and medium enterprises.

(3) Counterpart Personnel

The Team requested the Cambodia side that necessary number of counterpart personnel shall be assigned to the Project and necessary arrangements with related organizations be made during the implementing stage in Cambodia.

(4) Customs Duties and Tax Exemption

The Cambodia side agreed that RGC shall be responsible for the exemption of all customs, tax, levies and duties incurred in Cambodia for the implementation of the Project.

(5) Climate Change

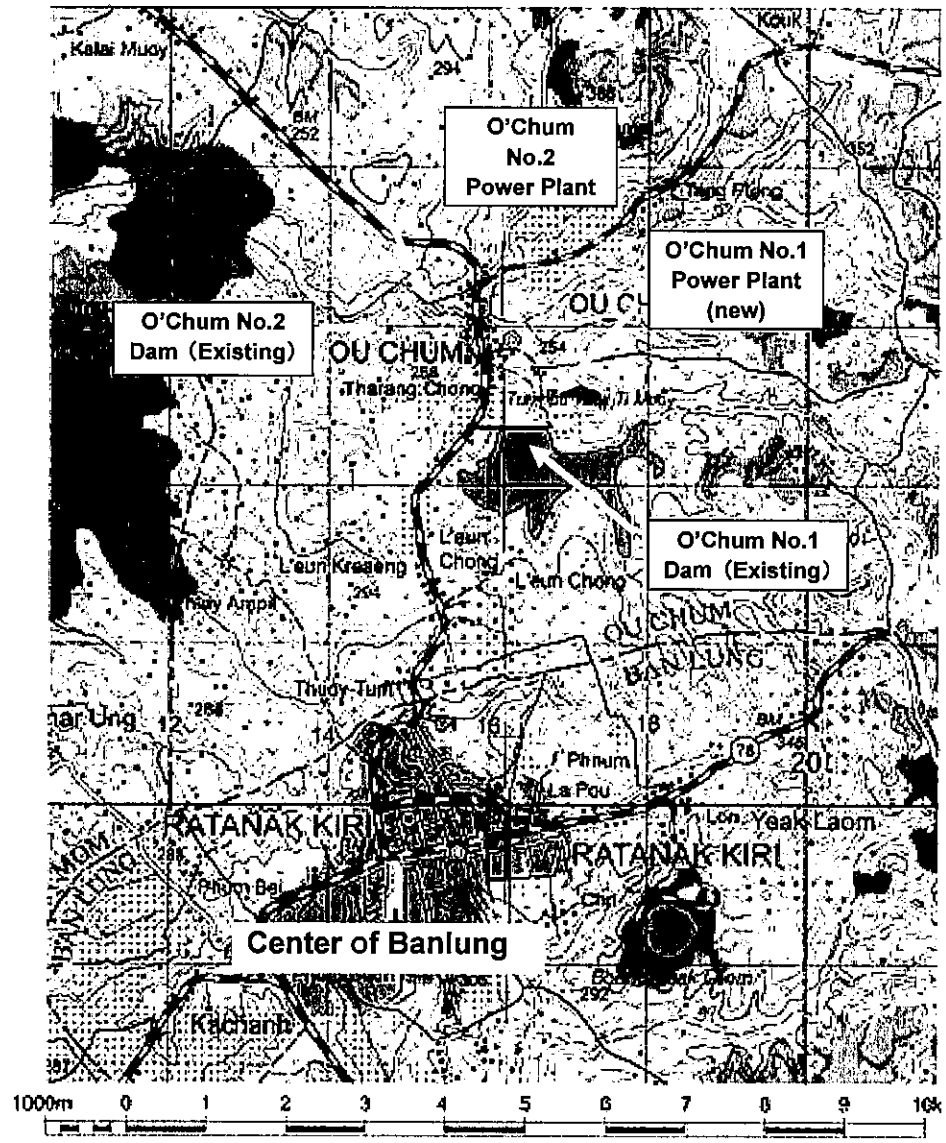
Both sides confirmed the project is expected to contribute to mitigation of climate change.

(End)

Annex-1	Project Sites
Annex-2	Organization Chart of MIME
Annex-3	Organization Chart of EDC
Annex-4	Japan's Grant Aid
Annex-5	Flow Chart of Japan's Grant Aid Procedures
Annex-6	Project Cost
Annex-7	Environmental Checklist
Annex-8	Monitoring Form
Annex-9	Major Undertakings to be taken by Each Government

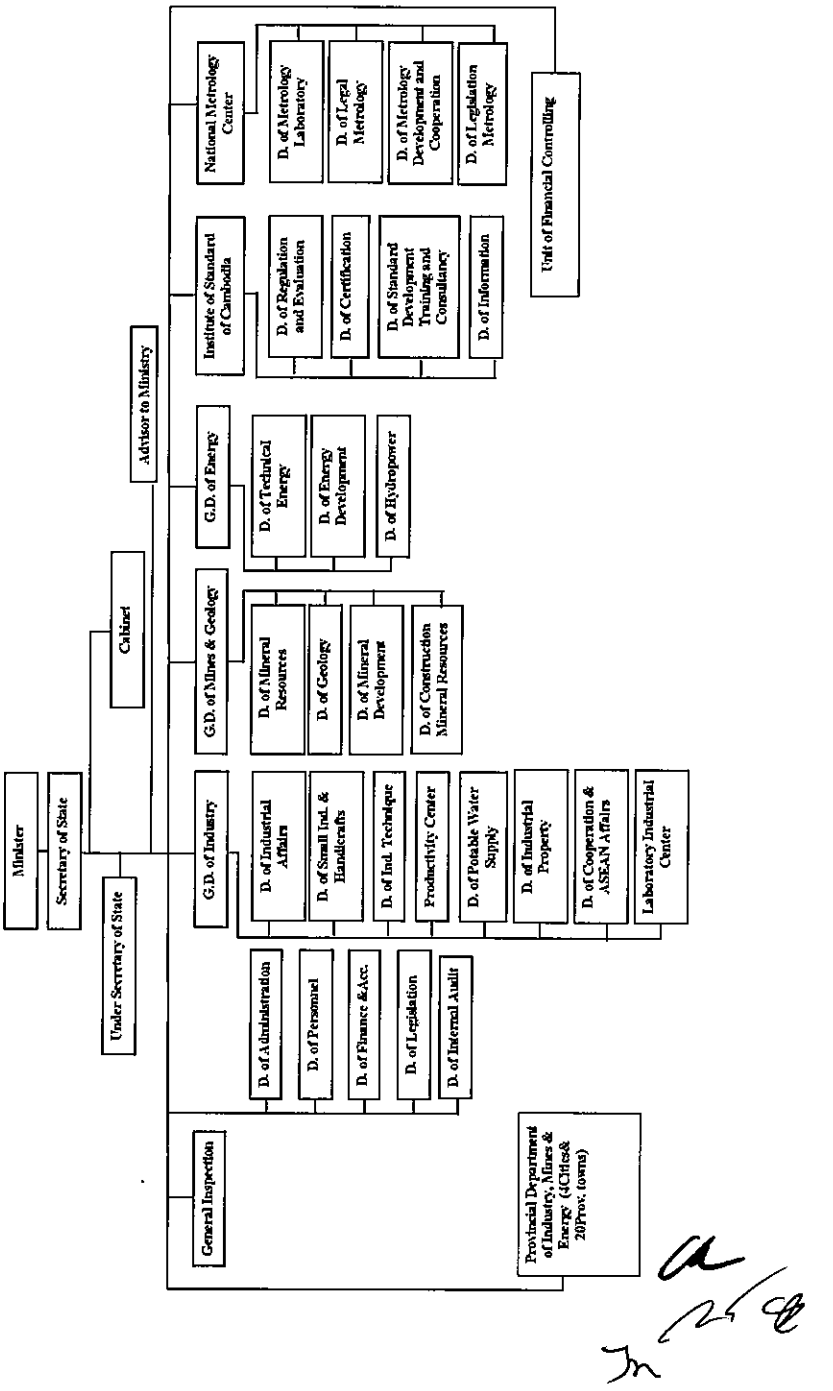
Annex 1

Project Sites



Annex 2

Organization Chart of MIME



Electricité du Cambodge

Organization Chart of EDC

10/ 2012

- **Chairman Board of Directors** 07 — TUN LEAN
  - **Managing Director** 01 — KEO ROTTANAK
    - Secretary of The Board 0
    - EDC Consultant 03
    - Secretariat of MD 03 — SRUN VEASNA (C)
    - Information Technology Office 12 — KAN THAY (C)
    - Inspection Office 19 — LIM SOK (C)
    - Internal Audit Office 09 — SOK DARAROAT (C)
    - **DMD of Administration** 01 — ÉNG KUNTHEA
      - Administration Department 101 — LY TIKHEA (D)
        - Protocol Office 04 — CHAN VIBOLLA (C)
        - Administration Office 50 — BONG SARUN (C)
        - Construction Office 04 — MA SAM AL (C)
        - Personnel Office 29 — TOUCH SOPHANY (C)
        - Payroll Office 07 — CHHOU SOK LENG (C)
        - Litigation Office 05 — CHEA MONIRATH (C)
      - Institute of Electical Science 53 — OUM PISETH (D)
        - Administration and Acounnting Office 25 — HONG KHEMROATH (C)
        - Foundation Year Department 02 — MENG SOTHA (C)
        - Academy Affair Office 02 — TIM CHANMAHONG (C)
        - Technical Training Office 18 — SY MOENG (C)
        - Electrical Department 02 — SOK PAL (C)
      - Autonomous Units
        - Power Plant N°3 34 — CHHITH SOVOUNG (C)
        - Power Plant N°5-6 104 — CHHAY PHALLA (C)
      - Provincial Electricity Units
        - Electricity of Siem Reap 182 — CHEAM KOSEN (C)
        - Electricity of Sihanouk Province 108 — CHEA SOBUDDHI (C)
        - Electricity of Kampong Cham 112 — MOA HUOR (C)
        - Electricity of Takeo 71 — UNG SORPHONTARA (C)
        - Electricity of Battam Bang 170 — TIV RAVUTH (C)
        - Electricity of Kam Pot 78 — CHHIM SOEUN (C)
        - Electricity of Prey Veng 50 — SUON SOKUN (C)
        - Electricity of Banteay Meanchey 88 — PUTH SOPHEAK (C)
        - Electricity of Stung Trèng 35 — POV ANGKEAVY (C)
        - Electricity of Rattanak Kiri 44 — PHAN KOSAL (C)
        - Electricity of Svay Rieng 75 — SIM SITHOR (C)
        - Electricity of Mondul Kiri 49 — CHIN SOKHUN (C)
        - Electricity of Kompong Speu 32 — CHEN TARA (C)
        - Electricity of Kratié 34 — RIM YON (C)
    - **DMD of Finance and Business** 01 — CHHUNG UNG
      - Finance and Accounting Dep. 31 — SIN SOVANNY (D)
        - Finance Office 08 — CHEA BUNTHÂN (C)
        - Accounting Office 09 — KEO PICH (C)
        - Centralization Office 07 — SÉNG SOKHA (C)
        - Corporate Finance Office 05 — VAN LIDA (C)
      - Business and Distribution Dept. 1046 — CHEA SIN HELYD
        - Distribution Network Unit 168 — HANG TOUCH (C)
        - Dispatching Command Center 83 — OR VADDHANA (C)
        - Electrical Equipment Unit 21 — TOUK MENG SRUN (C)
        - Workshop Unit 22 — CHHUN TY (C)
        - Material Supply Planning Office 08 — CHEA TRY (C)
        - Distributive Technical Office 20 — OUK CHETRA (C)
        - Electrical energy loss Management Office 16 — OUK VUTHY
        - Customer Office 11 — MIN CHANTHUL (C)
        - Marketing Office 04 — LONH SOPHAL (C)
        - Agency's Supervision Office 05 — TIT SARAMONY (C)
        - Provincial Unit's Supervision Office 04 — SEANG SAODIN (C)
        - Billing and Data Management Office 07 — PEANG KUNTHEA (C)
        - Agency O BEK KA AM 276 — IM SOPHAN (C)
        - Agency WAT PHNOM 196 — KONG PHALLA (C)
        - Agency CHAK ANGRE KROM 188 — KAN CHHUNTY (C)
        - Administration Division 09 — SOK SOTHEA (C)
        - Administration Section 05 — NHEM PHOEUN (C)
        - Procedure Section 0
      - *Internal Audit Department Suspending*
    - **DMD of Planning and Technique** 01 — CHAN SODAVATH
      - Corporate Planning&Project Dep. 112 — PRAING CHULASA (D)
        - International Cooperation Office 03 — PHÄL SAMBATH (C)
        - Planning Management Information System and Tariff Office 11 — TEK SOCHEAT (C)
        - Technical Office 29 — HOUNG CHANTHA (C)
        - Project Management Office I 15 — CHHIM MAN (C)
        - Project Management Office II 20 — KONG PUTHY (C)
        - Private Project Management Office 09 — EAV RIT TOUCH (C)
        - S.E & Public Relation Office 08 — MAO VISAL (C)
        - System Analysis&GIS Office 05 — THACH SOVANNREASEY (C)
        - Secretariat 09
      - Transmission Department 228 — NOU SOKHON (D)
        - National Control Center (Unit) 37 — LIM SISOPHORN (C)
        - Transmission System Unit 158 — MAK THORN (C)
        - Relay Protection Office 16 — KHY SOKHAN (C)
        - Administration Division 14 — SOK CHAMNAB (C)
      - Generation Department 22 — ROS CHENDA (D)
        - Planning and Generation Office 05 — MAK SOKOMA (C)
        - Technical Office 07 — PÈN PHA (C)
        - Secretariat 08 — SÄM PHARY (C)
    - **DMD of Rural Electrification Found** 01 — KEO VIRAC
      - Rural Electrification Found Dep. 16 — LOEUNG KEOSEYLA
        - Admin-Finance Office 01 — IN VIRALEAKHENA
        - Technical Planning Monitoring and Evalunation Office 01 — KIM RITHY
      - Procurement Department 67 — NGETH SOKHAN (D)
        - Project Procurement Office 14 — DORK SOVANMONY (C)
        - EDC Procurement Office 11 — HENG SOCHEATH (C)
        - Warehouse and Logistic Office 36 — ROS BUTH THA (C)
        - Administration Section 04 — TEP NARANN (C)

Grand total	:	2994 P (10 / 2012)
Included :		
- Permanent staffs	:	2928 P
- Contractual staffs	:	66 P
Total EDC (Phom Penh)	:	1866 P (10 / 2012)
Included :		
- Non autonomous Units	:	1728 P
- Autonomous Units	:	138 P
Total EDC (Provinces)	:	1128 P (10 / 2012)

PhomPenh 06 November 2012

For RGC Delegate in Charge of Managing EDC

Deputy Managing Director

ENG KUN THEA

JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - -Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - -The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - -Agreement concluded between JICA and a recipient country
- Implementation
  - -Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of a basic design of the Project.

- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex-9.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

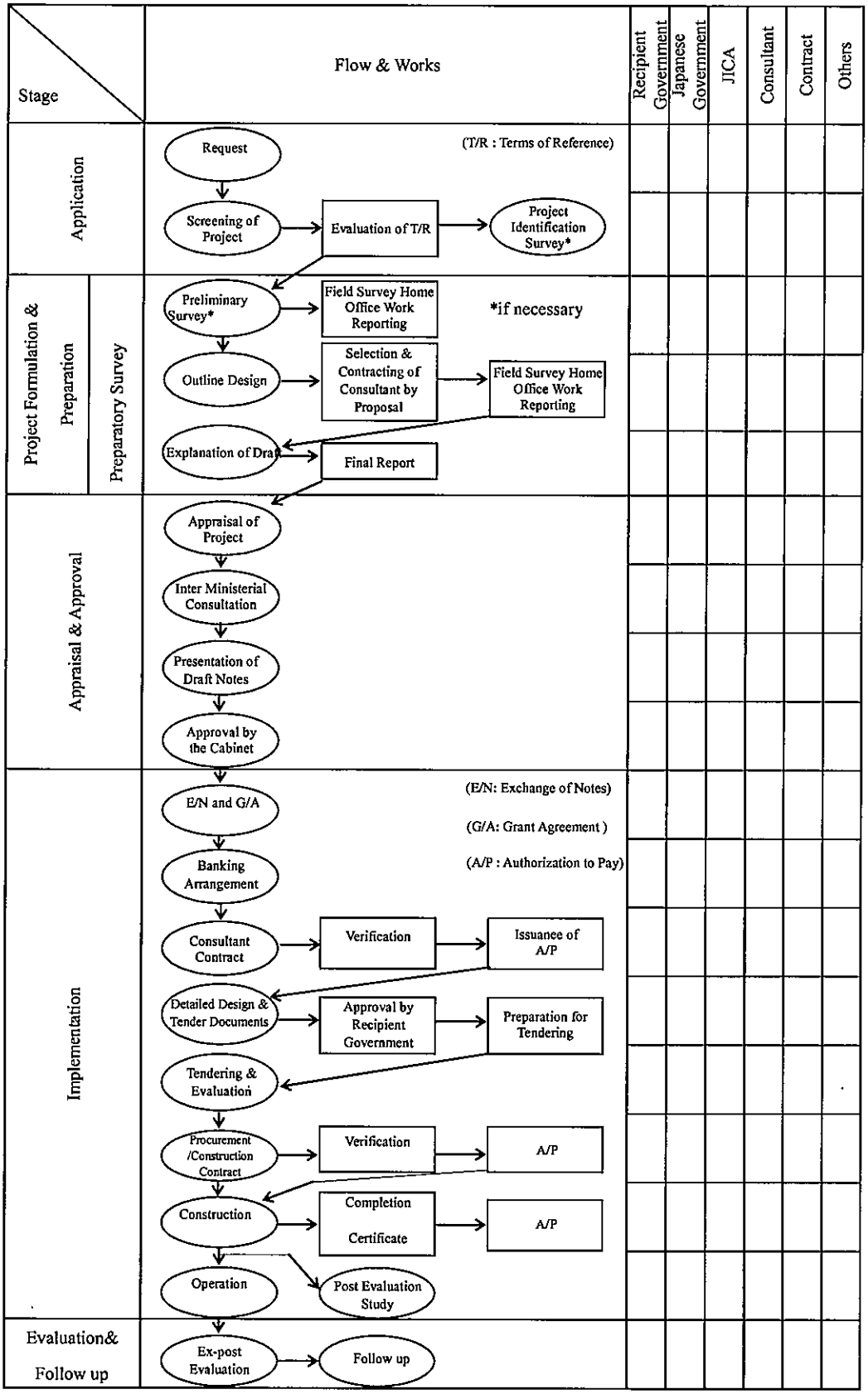
(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

(End)

Annex-5

Flow Chart of Japan's Grant Aid Procedures



Annex-6

(Confidential)
Estimated Project Cost

The cost of the Project will be approximately JPY 1,167 million in total. The content of the project cost are shown separately for the Japanese borne portion and Cambodia side borne portion in accordance with the conditions in item 3.(3) below.

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

1. Cost to be borne by the Japanese side: Approximately JPY 1,166 million

Approximate Total cost for Japanese Portion

Cost Items	Approximate Cost (million JPY)
Equipment Procurement, Installation, Construction	1,014
Detailed Design & Consultant's Supervision	152
Total	1,166

2. Cost to be borne by the Cambodia side: USD 12,500 (=approximately JPY 1 million)

(1) Payment of bank commission based on banking US$ 12,500 (=¥1million)
- A/P commission
- Payment commission

3. Conditions for estimation
   (1) Time of estimation: August, 2012 (Average from February. 2012 to July 2012)
   (2) Foreign exchange rates:

   1USD = JPY 81.06

   (3) Others:

   The above estimation was carried out in accordance with relevant rules and the guideline of the Japanese Grant Aid.

Environmental Check list

In accordance with the JICA Guidelines for Environmental and Social Considerations (April, 2010), environmental and social items are evaluated. The evaluation results and mitigation measures concerned are summarized in the tables below. The followings are meanings of the scores for evaluation results in the tables.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown.
(A further examination needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
N/A: Not applicable
- : item excluded from evaluation

Table 1. Environmental check list (1) —Pollution Control—

Category	Items to be checked	Evaluation: During construction	Evaluation: After construction	Results of the survey Reasons for evaluation & Mitigation measures
(1) Water Quality	【Hydropower】			
	(a) Water quality in reservoir, & Quality standard * a possibility that proliferation of phytoplankton and zooplankton	D	D	As for planktons concerned, a proliferation will hardly occur due to the following reasons. Upgrading of an intake of O Chum No.1 dam makes the lowest water level for discharging higher, which causes an increase of dead storage water. The amount of the water is approximately 6.50 million cubic meters, while the total amount of inflow water to the reservoir is 34.4 million cubic meters. This means the dead storage water could be replaced 5 times a year. It is generally considered that proliferation of plankton does not happen when water stock is replaced more than twice a year. In addition, upstream of the reservoir is a depopulated area. Therefore, it may discharge less human sewage that may cause eutrophication leading proliferation of planktons.

	(b) Quality of water discharged	D	D	It is not expected that the quality of discharged water will be adversely affected since the project renovate/rehabilitate the existing dam, but doesn't develop new dam. Civil engineering work is possible source to cause turbid water during construction period. Generally for dam renovation/rehabilitation project, a temporary dike is often constructed in order to keep river water from leaching a place for civil work. It is common to install pipes to discharge water from temporary dike to downstream side. These pipes take surface water in the dike which is cleaner than turbid water stagnating at depth of the dike. For this project, temporary dike is constructed in a common method described above, so it is expected that significant turbid water will not occur. Besides, considering volume of discharged water, turbid water, if it occurs, may not affect to downstream. Turbidity of discharged water is expected to be as same as or less than what is caused naturally by rainfall in rain season.
	(c) Woody vegetation in the reservoir	D	D	Woody vegetation in the reservoir was already cleared by the prior project.
	(d) Water quality degradation in downstream area caused by the reduced river flow	C	D	It is not expected that water flow will reduce since this project renovates/rehabilitates the existing dam. The civil work that may affect water flow is planned to be conducted in dry season . Statistics data on river flow in dry season does not exist. However, according to rain fall record, river water flow will be very small. (It can be assumed that water quality degradation will not occur if volume of river flow to downstream is kept in dry season during construction period) 【Mitigation Measures】 A pipe to discharge water to downstream area should be installed at a temporary dike during construction period
	(e) Water discharged from the lower portion of the dam reservoir (the water temperature of the lower portion)	D	D	Water depth in the reservoir is 14.5 meters, only of which 5 meters from surface of water level will be used for generation. Therefore, it is almost same as to use surface water which does not bring water of lower temperature.

	【Transmission line】			
	(f) Degradation of water quality degradation caused by soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling water areas	D	D	The project install distribution lines but not build transmission tower. The line root will be along the existing street, therefore, no negative impacts happen to river..
(2) Waste	【Hydropower】			
	(a) Treatment of earth and sand generated by excavation	D	D	The largest civil engineering work could be construction of temporary dike in the current O'Chum No.1 reservoir in order to keep water from leaching an intake tower during its improvement work. Soil in the reservoir (near spillway) will be used to build the dike. The dike will be removed, and the soil will be filled back to lower area within the reservoir after the improvement work is completed. Therefore, soil erosion to downstream of the dam would hardly happen.
	(b) Pole transformer which contain PCB	D	D	The project does not replace any existing pole transformers.

Table 2. Environmental check list (2) —Natural Environment—

Category	Items to be checked	Evaluation: During construction	Evaluation: After construction	Results of the survey Reasons for evaluation & Mitigation measures
(1) Protected Area	【Hydropower・Transmission line】			
	(a) Location of protected area, Impacts on protected area	D	D	A protect area does not locate in/near to project area. There are two natural reserves protected by law in Ratanakiri province. They are Virachay National Park, and Lomphat Sanctuary both of which are far from project area by more than 35 km with direct distance.
(2) Eco-system	【Hydropower・Transmission line】			
	(a) ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)	D	D	There are not such places.
	(b) protected habitats of endangered species	D	D	The project does not encompass such habitat.

	【Hydropower】			
	(c) Adversely impacts to downstream aquatic organisms, animals, plants, and ecosystems	D	D	During construction period, even after temporary dike is build, water is discharged to downstream area through pipes installed. It would not be expected to cause negative impacts on animals, plants and ecosystems.
	(d) Impacts on migratory fish species	D	D	There is no migratory fish species found in the project area.
	【Transmission line】			
	(e) Significant ecological impacts on the ecosystem	D	D	No significant impacts are anticipated The project does not include a large-scale civil engineering work such as construction of transmission towers The line will be installed along the existing road.
	(f) Disruption of migration routes and habitat fragmentation of wildlife and livestock	D	D	The project components do not include distribution line and/or construction work which disrupt migration routes of wildlife and livestock
	(g) Destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem	D	D	The project area does not include natural forest nor wetland areas. In addition, a scale of civil engineering work is relatively small.
	(h) Extensive loss of natural environments in undeveloped areas	D	D	It's not applicable to this project. (The project site locates in developed area)
(3) Hydrology	【Hydropower】			
	(a) Hydrologic changes due to the installation of structures, such as weirs (especially in "run off the river generation" projects)	D	D	The project is not "run off the river" type. The project installs water pipe of which length is 250m, and so, a flow of surface water will change only around that area. However, it will not bring negative impacts due to its small –scale of the facility
(4) Topography and Geology	【Hydropower】			
	(a) Reductions in sediment loads at downstream area, Sedimentation of the reservoir	D	D	It's not applicable (the project components does not include construction of dam reservoir) 。
	(b) A large-scale alteration of the topographic features and geologic structures in the surrounding areas	D	D	The physical scale of facilities in the project is small, and does not cause a large scale alteration of the topographic features. To make water intake higher location, the lowest water level in dry season become also higher. However, this does not means that maximum water level in the reservoir become higher nor bring a large scale alternation of the topographic features.

	【Transmission line】			
	(c) Slope failures or landslides	D	D	Distribution line does not run on the places where slope failures or landslides likely occur.
	(d) Civil works, such as cutting and filling causing slope failures or landslides	D	D	The civil work is relatively small, and could not bring slope failure nor land slope.
	(e) Soil runoff resulting from cut and fill areas, waste soil disposal sites, and borrow sites.	D	D	The project does not bring such runoff since the civil work is relatively small.

Table 3 Environmental check list (3) —Social Environment—

Category	Items to be checked	Evaluation: During construction	Evaluation: After construction	Results of the survey Reasons for evaluation & Mitigation measures
(1) Resettlement	【Hydropower・Transmission line】			
	(a) Involuntary Resettlement	B⁻	B⁻	It is identified that two families plants cashew nuts trees near candidate site for construction of power plant on EDC's land.. These families need to quit farming in that land. However, they have their own residences in O'Chum village, so, they can live there continuously as same as they are currently doing. Administrative road in 'O'Chum No.1 is constructed in EDC's land, so involuntary resettlement does not occur for that. 【Mitigation Measures to be taken】 EDC already paid 1,000 USD to the two families for compensation. . (Sep. 2012) In livelihood restoration program, EDC will employ the head of family who lost its main income source (cashew nuts plantation on EDC's land)
(2) Life/Lively-hood	【Hydropower・Transmission line】			
	(a) Adversely impacts on the living conditions of inhabitants	D	D	A power plant will be constructed on the land of EDC, The administrative road and distribution line will be constructed at far from villages. Therefore, no negative impacts caused by vehicles for construction work is anticipated.
	(b) Diseases due to immigration of workers associated with the project	D	D	Operation and maintenance of the project facilities do not cause immigration. For construction work, most of workers except skilled ones could be employed from communities in/around the project site.

【Hydropower】			
(c) Change of land uses in the neighboring areas, adversely affecting livelihood of local people	C⁻	C⁻	Water level in O'Chun No1 dam reservoir goes up in dry season due to improvement of facilities. It was reported that someone plant vegetable at the places which appear in the reservoir only in dry season. The study team could not confirm that, therefore, EDC was asked to conduct follow-up survey. It is necessary for JICA to support EDC in case there is someone affected by the project. (refer to Section 1.3.8 of the draft of preparatory survey report)
(d) Negative impacts on traffic systems	D	D	There is no water traffic. No negative impacts caused by the project facilities are expected for traffic system In observation, there was not so much traffic around the project area. Therefore the project will not bring negative impacts on the traffic.
(e) The minimum flow required for maintaining downstream water uses	B⁻	D	A volume of water flow does not change before/after the construction of the project facilities. According to the interview, water flow becomes small in dray season, but not dried up. 【Mitigation Measures】 A pipe to discharge water to downstream area should be installed at a temporary dike during construction period.
(f) Reductions in water flow affecting water use and land uses in downstream area	B⁻	B⁺	It is identified that water is used for washing, and rarely drinking when ceremony As mitigation measure, a pipe to discharge water to downstream area should be installed in construction period After the construction of the project facilities, volume of water flow will not change. After starting of operation of new hydro power plantation, water flow between O'Chum No1 and No2 becomes stable through year. 【Mitigation Measures】 A pipe to discharge water to downstream area should be installed at a temporary dike during construction period
(g) Water-borne or water-related diseases	D	D	Few possibilities are identified since the project components do not include construction of reservoir.

	(h) Fishery rights, water usage rights, and common usage rights	D	B^+	In O'Chum dam No1 reservoir, community members release fish and manage it. The area for civil work in the reservoir is estimated to be 16,000 m2 at maximum, which accounts for less than 1 % of total area of the reservoir. Therefore, no negative impact on fish will be anticipated. It is recommended that fish should be released after construction if community member show their concern about this issue. Due to improvement of facilities, water level in the reservoir goes up which may bring better condition for fish to grow. 【Additional Consideration】 Although the civil work by the project will not affect adversely fishes in the reservoir, it is recommended that fish should be released into the reservoir after construction if community member show their concern about this issue.
	【Transmission line】			
	(i) Radio interference	D	D	Distribution line by the project does not cause radio interference because of its low voltage capacity.
	(j) A compensations for transmission wires given in accordance with the domestic law	D	D	The project will install low voltage distribution line. Under the current regulations. EDC does not have legal obligation to pay compensation for ROW of distribution line.
(3) Heritage	【Hydropower・Transmission line】			
	(a) Negative impacts on the local archeological, historical, cultural, and religious heritage	D	D	No heritage is identified in/around the project site.
(4) Landscape	【Hydropower・Transmission line】			
	(a) Negative impacts on Landscape	B	B	There is small water fall in downstream area of O'Chum No1.dam. 【Mitigation Measures】 To minimize negative impacts on landscape around water fall,, the generator house will be built at the place so that it is not directly seen from the downstream of the water fall. Also, trees around the generator house will not logged as much as possible.

(5) Ethnic minority	【Hydropower・Transmission line】			
	(a) Minimization of negative impacts on the culture and life style of ethnic minorities and indigenous peoples	D	D	Approximately 90 % of people in Ratanakiri province is ethnic minority. There are three villages around the project site where ethnic minorities; Kroeung, Tompuon and Prav are lining. It is observed that they still keep their own social and cultural characteristics as ethnic minority, and are now in assimilation into Khmer. The project components such as construction of power plant and transmission line will not adversely affect their culture and life style.
	(b) Respect on all of the rights of ethnic minorities and indigenous peoples in relation to land and resources	D	D	According to the interview with village leaders, they understand that the land for construction of project facilities belong to EDC which does not include places where they take natural resources.
(6) Working conditions	【Hydropower・Transmission line】			
	(a) laws and ordinances associated with the working conditions	D	D	To comply with related laws such as labour Law (1997)
	(b) tangible safety considerations for working conditions	D	—	To comply with related laws such as labour Law (1997)
	(c) Intangible measures for working conditions	D	—	The followings are considered. -to always put helmet, - and put safety belt, safety boots and dust mask if necessary -to enclose dangerous area by fence, and put board for attention.
	(d) Appropriate measures taken to ensure that security guards involved in the project not to violate safety of stakeholders	D	D	There is no serious issue on safety found in the project area. Community members do not look to be against the project. Security guard will be hired from communities, or security of the construction site is managed with cooperation of communities.
	(e) Land mine, UXO	D	D	According to the interview with community members, Any cases of landmine and UXO are not reported around the project site 【Additional Consideration】 Sign boards which alert landmine and UXO are found along streets around Banlung city. Careful attention should be paid during construction period

Table 4 Environmental check list (4) —Others—

Category	Items to be checked	Evaluation: During construction	Evaluation: After construction	Results of the survey Reasons for evaluation
(1) Impacts during Construction	【Hydropower・Transmission line】			
	(a) impacts by noise, vibrations, turbid water, dust, exhaust gases, and wastes	D	—	In this project, a portion of civil engineering works is small. (It accounts for approximately only 20% of the total cost estimated) Heavy machinery working is also small in number. The civil works for a construction of power plant in O'Chum No.1(including generator house, water pipe, administration road), and for rehabilitation of administrative road in O'Chum No.2 don't require blasting operation, nor concrete aggregate plant. Therefore, any negative impact by noise, vibration, turbid water will not be anticipated. Residential area is far by at least 300 m from the construction site in O'Chum No.1, so vibration and noise from heavy machinery will not affect them. There is no village along administrative road in O'Chum No2. So, totally, negative impacts on both of environmental and social aspects are not anticipated. As for turbid water, see the item (1) (c) of Table 1. As for waste, see the item (2)(a) of Table 1
(2) Accident Prevention Measures	【Hydropower】			
	(a) warning system to alert the inhabitants to water discharge from the dam	D	D	Planed volume of water discharge is 2-3 m3/sec, which is same volume as by current practice. From field observation, a volume of water from spillway is estimated 4-5 m3/sec. Considering these small volumes discharged, no warning system required.
(3) Monitoring	【Hydropower・Transmission line】			
	(a) Planning & implementation of monitoring program	B-	B-	Through overall consideration, monitoring apart from for resettlement is required only for construction period. (See Monitoring Form in Annex 8) Monitoring regarding resettlement is described in in Annex 8)
	(b) Items, methods and frequencies of the monitoring program	B-	B-	See Monitoring Form in Annex 8
	(c) Monitoring organization, personnel	B-	B-	See Monitoring Form in Annex 8

Others	(d) Report of monitoring	B^-	B^-	Monitoring items during construction period described in Monitoring Form in Annex 8 are reported monthly to related organizations including district office and commune office. Monitoring items regarding resettlement, should be reported annually to JICA and related organizations.
	【Hydropower・Transmission line】			
	(a) Global issue	D	B^+	The electricity generated by the project will replace those imported from Vietnam. It can be assumed that emission of CO2 is reduced for this portion.

MONITORING FORM

-If environmental reviews indicate the need of monitoring by JICA, JICA undertakes monitoring for necessary items that are decided by environmental reviews. JICA undertakes monitoring based on regular reports including measured data submitted by the project proponent. When necessary, the project proponent should refer to the following monitoring form for submitting reports.

-When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

1. Responses/Actions to Comments and Guidance from Government Authorities and the Public

Not applicable.

Monitoring Item	Monitoring Results during Report Period
-	-

2. Mitigation Measures

2.1 Air Quality (Emission Gas / Ambient Air Quality)

Not applicable.

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
SO_2	N/A	-	-	-	-	-
NO_2	N/A	-	-	-	-	-
CO	N/A	-	-	-	-	-
O_3	N/A	-	-	-	-	-
Soot and dust	N/A	-	-	-	-	-
SPM	N/A	-	-	-	-	-
Dust	N/A	-	-	-	-	-

2.2 Water Quality (Effluent/Wastewater/Ambient Water Quality)

Not applicable.

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-	-	-	-	-	-
SS (Suspended Solid)	-	-	-	-	-	-
BOD/COD	-	-	-	-	-	-
DO	-	-	-	-	-	-
Total Nitrogen NO_3	-	-	-	-	-	-
Total Phosphorus$_3$ PO_4	-	-	-	-	-	-
Heavy Metals	-	-	-	-	-	-
Hydrocarbons / Mineral Oils	-	-	-	-	-	-
Phenols	-	-	-	-	-	-
Cyanide	-	-	-	-	-	-
Temperature	-	-	-	-	-	-

2.3 Waste-

Not applicable

2.4 Noise / Vibration

Not applicable

2.5 Social Consideration

Category	Monitoring Items	Method, Frequency & Remarks
Water discharged to downstream area in O'Chum No1 dam during construction period (water utilization for villagers)	+ Volume of discharged + turbidity	+ discharged water from pipes installed at temporary dike. + Daily in dry season during construction period + by visual check + At least by 100 liters/sec when river water exists.

Monitoring should be conducted by a constructor

3. Livelihood Restoration Program

Conduct monitoring and report by EDC

Category	Items / Information for monitoring & reporting	Timing of monitoring/ reporting
Employment of the family head	+ Employment Contract (Copy of the document)	When employed (January 2013)
Cash income of the family	+Total amount of cash income by the family + Amount paid by EDC as salary	+ Monitoring quarterly (first monitoring will be conducted April 2013) + Reporting Annually

Annex-9

Major undertakings to be taken by each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	to secure [a lot] /[lots] of land necessary for the implementation of the Project and to clear the [site]/[sites];		●
2	To construct the following facilities		
	1) The building	●	
	2) The gates and fences in and around the site		●
	3) The parking lot	●	
	4) The road within the site	●	
	5) The road outside the site		●
3	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the [site]/[sites]		
	1)Electricity		
	a. The distributing power line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the Products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services [be exempted] / [be borne by the Authority without using the Grant]		●
6	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To ensure that [the Facilities and the products]/[the Facilities]/ [the products] be maintained and used properly and effectively for the implementation of the Project		●
8	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		●
9	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
10	To give due environmental and social consideration in the implementation of the Project.		●

*1 B/A : Banking Arrangement, A/P : Authorization to pay) *2 If the environmental screening category is C, No. 10 is unnecessary