

**BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT
OF
WATER SUPPLY SYSTEM IN SIEM REAP TOWN
IN
THE KINGDOM OF CAMBODIA**

NOVEMBER 2003

**JAPAN INTERNATIONAL COOPERATION AGENCY
NJS CONSULTANTS CO., LTD.**

PREFACE

In response to a request from the Royal Government of Cambodia, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Water Supply System in Siem Reap Town and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team from 2nd March to 10th April, 24th June to 9th July, 2nd July to 5th August, and 7th August to 19th August 2003.

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

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

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

November 2003

Kunimitsu Yoshinaga
Vice-President
Japan International Cooperation Agency

November 2003

LETTER OF TRANSMITTAL

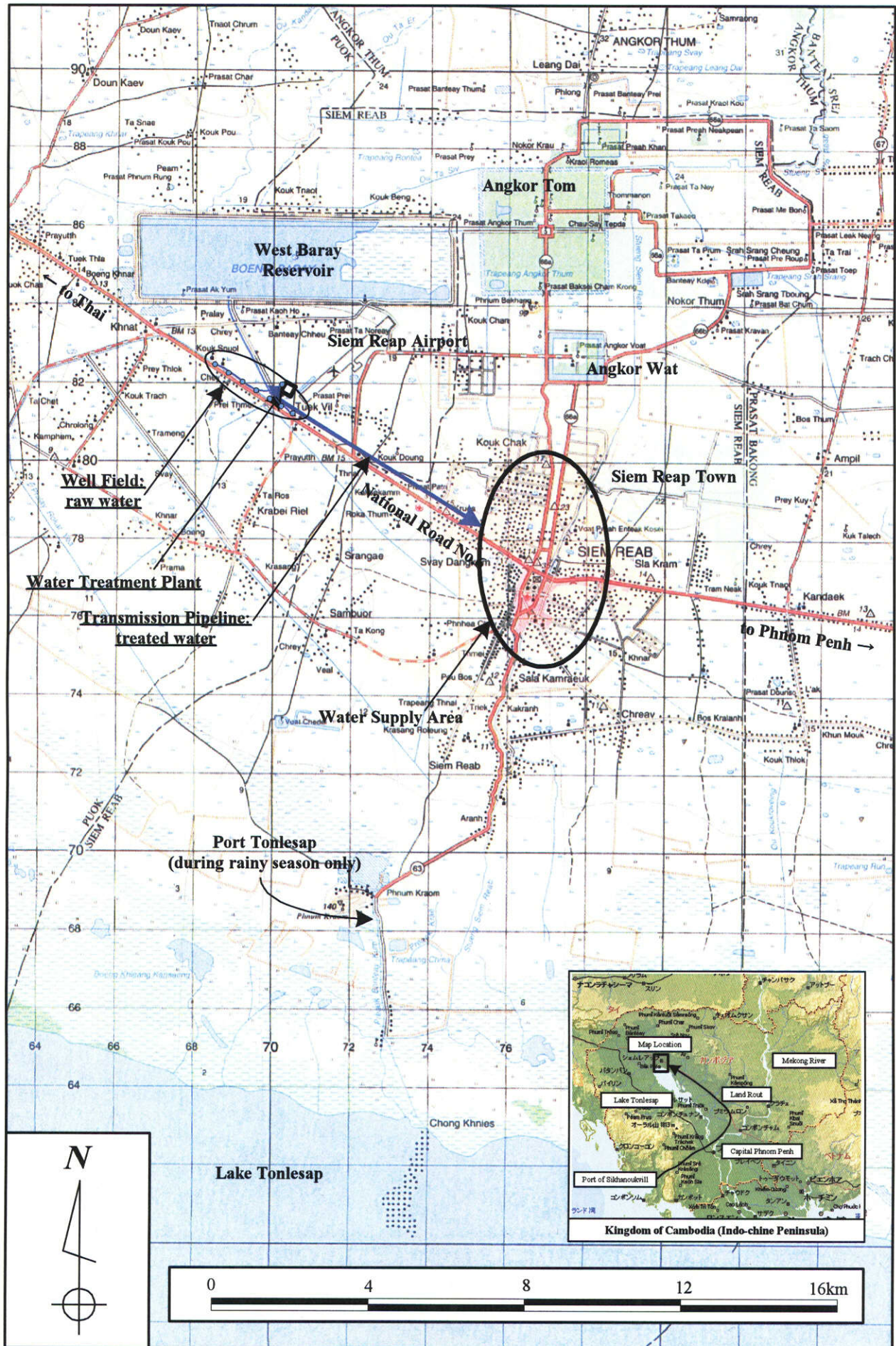
We are pleased to submit to you the basic design study report on the Project for Improvement of Water Supply System in Siem Reap Town in the Kingdom of Cambodia.

This study was conducted by NJS Consultants Co., Ltd. under a contract to JICA, during the period from February to November 2003. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Cambodia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,

Yoshihiko Sato
Project Manager,
Basic design study team on
the Project for Improvement of Water Supply System
in Siem Reap Town
NJS Consultants Co., Ltd.



Location Map of Project

FIELD PICTURES



Photo 1 : Siem Reap Water Supply System (SRWSS)



Photo 2 :The existing water treatment plant



Photo 3 : Raw water
Capacity:60 m³/hr 18.5 kW



Photo 4 : Aeration tank with pH adjustment by Lime



Photo 5 : Oxidation tank



Photo 6 : Storage tank before filtration



Photo 7 : Filtration units for iron removal



Photo 8 : Clear water reservoir (850m³)



Photo 9 : Clear water lifting pumps (15 kW x 2 units)



Photo 10 : Elevated tank (500m³)



Photo 11 : Distribution pipe on a existing bridge



Photo 12 : Generator (130kVA + 100kVA)



カンボジア王国シェムリアップ上水道整備計画基本設計調査

THE BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY SYSTEM
IN SIEM REAP TOWN IN THE KINGDOM OF CAMBODIA

EXECUTIVE SUMMARY

The Kingdom of Cambodia is located in the center of the Indochina Peninsula and covers an area of 181,000 km², being bordered by Vietnam on the east, the People's Democratic Republic of Laos on the north, Thailand on the west, and the Bay of Thailand on the south. The year 2000 population was 12.02 million people, of which 1.8 million, equivalent to 16 percent of the total, resided in urban areas. The per capita gross national income in 2000 amounted to US\$ 260. Siem Reap town (116,211 people in 2001) is located 240 km northwest of the national capital Phnom Penh, and is approximately 5 km south of the Angkor Heritage site. The climate of the study area is tropical with high temperature and humidity. The wet season generally occurs from May to October, with November to April being the dry season. The average annual total precipitation is approximately 1,500 mm. The highest, lowest, and average temperatures recorded from year 2000 to 2002 were 35, 21, and 28 °C, respectively.

Following the end of the internal war in 1991, reconstruction of the country commenced with the support of the international community and an average annual GDP growth rate of 6.1 percent was achieved over the period 1994 to 1996. However, economic growth slowed to 3.7 percent in 1997 and 1.5 percent in 1998 as a result of the Asian economic crisis and the adverse effect of an armed coup in 1997. Since then, economic reforms have been implemented and recently the Cambodian economy has shown signs of improvement, with GDP growth rates in 2000 and 2001 being 5.4 and 5.3 percent, respectively.

The Royal Government of Cambodia (RGC) is currently implementing the Second Five Year Socio-economic Development Plan 2001-2005 (SEDP II) which is closely linked to the National Poverty Reduction Strategy (NPRS). The main objectives of the SEDP II are to achieve i) a rapid and broad-based sustainable economic growth and increase the accessibility of the poor to economic activities, ii) enhancement of human resources by improving the access of the poor to education, health, water and sanitation, power, credit, markets, information and appropriate technology, and iii) provision of safety nets for the socio-economically disadvantaged sectors through improved accessibility to the benefits of economic growth. In the water and sanitation sector, the RGC is committed to achieving the long-term goal of providing access to clean drinking water and environmental sanitation for the entire population, and aims at providing clean drinking water to 87 percent of the urban population by the end of 2005, compared to an estimated coverage of 48 percent in 2000.

At present, only 5.8 percent of the population of Cambodia has access to a safe and clean drinking water provided by piped water supply system. Approximately 40 percent of the population use shallow dug wells and 28 percent rely on untreated surface water from rivers and lakes. In Phnom Penh the water supply coverage is 85 percent, representing the highest in Cambodia, as a result of the grant in aid projects from the Government of Japan (GOJ) over the last 10 years. With only 10 percent of the population in the study area being provided with a piped water supply, basically in Siem Reap town, there is a high incidence of water-related diseases. The existing water supply system has a capacity of 1,400 m³/d, but the water treatment facilities have deteriorated and cannot cater to the increasing water demands.

Under the circumstances, the Japan International Cooperation Agency (JICA) conducted "The Study on Water Supply System for Siem Reap Region in Cambodia" over the period 1996 to 2000 under a technical cooperation agreement with GOJ, in order to develop a master plan for the water supply system for Siem Reap town through

undertaking a detailed analysis of population projections, water demand projections, evaluation of alternative of water sources, etc. The Master Plan (M/P) identified an urgent upgrading plan for the water supply system, which included 10 groundwater source development wells with a total design capacity of 8,000 m³/d, and a Feasibility Study (F/S) of this urgent plan was carried out to better define the preliminary design of the recommended scheme and the funding required. It was concluded that the project was feasible in terms of technical, economic/financial, and environmental aspects, and that it would have minimum negative impacts, particularly on lowering of the groundwater table and land subsidence in the study area that might be expected as a result of the groundwater source development under the project.

In the light of recommendations made in the F/S, RGC requested in January 2000 a grant in aid program from GOJ in order to implement the Project for Improvement of Water Supply System in Siem Reap Town (the Project). In response to this request by RGC, GOJ agreed to conduct a basic design study (B/D). In fulfillment of this agreement, JICA started the B/D in March 2003 in close cooperation with the concerned agencies of RGC. The Basic Design Study Team (Study Team) visited Cambodia on four occasions from March to August 2003 to undertake field surveys and to prepare this basic design report, which explains the basic concept, size, and characteristics of the Project. The first field study was carried from 2 March to 10 April, the second from 24 June to 9 July, the third from 2 July to 6 August, and the fourth field study from 7 to 19 August 2003. A further explanatory mission for draft basic design report was conducted from 5 to 12 October 2003.

The primary objectives of the B/D are to review the planning fundamentals of the F/S, which is the basis of request made by RGC, and to evaluate the appropriateness of the Project in consideration of i) avoidance of environmental impacts to the Angkor Heritage caused by the groundwater development under the Project, ii) the inclusion of additional service areas requested by RGC during the field study, iii) decreasing the number of constructed wells so as to minimize the Project cost, iv) to change the distribution system from direct pump to gravity feed in order to minimize the operation and maintenance cost, and v) the addition of an iron removal process in the water treatment plant following an investigation of raw water quality.

The target year for the Project has been set to be 2008, compared to the original target year of 2006 requested to GOJ in January 2000 based on the F/S. Since the Project must first satisfy the increase in water demand that will follow construction of the Project facilities, and thereby alleviate the current shortage of water supply in the study area, the target year for the Project has been moved forward to year 2008.

The total Project service area will be 425 ha, comprising the RGC original 345 ha service area prepared in the year 2000 F/S and the proposed additional service area of 80 ha raised during the first field survey. The proposed service areas are situated in the northwest of the study area along national road No. 6, and in Kokchak Commune. The population in these areas is anticipated to increase rapidly as a result of the increase in the tourism industry and a change in the land use zoning from military zone to residential.

Whilst the development of the tourism industry will result in a rapid increase of water demand in the study area, the priority for water supply under the Project will be for domestic and public demand, rather than the tourism industry per se in order to meet the fundamental development challenges of reducing poverty and improving the quality of life of the Cambodian people. Further, the total water demand including tourism is well in excess of the design capacity of the groundwater source proposed in the F/S. A large-scale development scheme would need to be considered if the project was to cater for both the tourism-related demand as well as that from the

local population, taking into account regional surface water sources as well as groundwater. A comprehensive water supply development scheme for Siem Reap Town would need to be based on a wider regional development plan.

The design coverage for residential water supply will be set at 65 percent of the population in the service areas, as proposed in the F/S, this coverage representing a realistic anticipated expansion of the required distribution and service pipes. The coverage for public, as similar to residential, demand will also be set at 65 percent, but because of the need to restrict the water production so as to control any adverse influence of groundwater development upon the Angkor Heritage site within acceptable limits, the design water supply coverage for the tourism sector will be limited to 40 percent. Expansion of the service coverage from the present 10 percent to the targeted water supply coverage in 2008 will be gradual, reflecting the needs or requests of the residents in the service areas, by installing individual consumer water meters to be procured by GOJ at RGC's cost.

The basic design study on the Project for Expansion of Phnom Penh Water Treatment Plant conducted in 2000 specified that the design domestic per capita consumption in Phnom Penh was 132 lpcd (liter per capita per day). The F/S indicated that the domestic per capita consumption for the Project would increase from 100 to 120 lpcd in the year 2010, based on a comparative study in other towns in Cambodia, data from other studies elsewhere, and the field study in the project area. The Study Team also conducted a field survey study and evaluated the relationship between water production and revenue collection achieved in 2001 and 2002, and concluded that the target of 120 lpcd was appropriate. Tourism water demand is projected to increase from 300 lpcd presently to 500 lpcd in the target year 2008. The present non-revenue water (NRW) ratio is of the order of 50 percent based on the records of water production and revenue collection studied in the field survey. The NRW ratio is expected to fall to 15 percent in the target year 2008 as the existing deteriorated pipes are replaced under the Project, a similar improvement having been witnessed in the Phnom Penh Water Supply Authority (PPWSA).

Based on the proposed basic design policy, Table 1 summarizes the proposed water supply plan in the Project through to year 2008. Table 2 outlines the proposed items to be included under the Project components.

Table 1 Water Supply Plan for the Project

Descriptions	2003	2004	2005	2006	2007	2008
Population	31,853	33,317	34,864	36,510	38,252	40,000
Served population	3,185	3,332	6,973	18,255	24,864	26,000
Service coverage (%)						
Domestic water (%)	10	10	20	50	65	65
Tourism water (%)	10	10	20	20	25	40
Public water (%)	10	10	40	50	60	65
Per capita consumption rate						
Domestic water (l/little)	100	100	105	110	115	120
Tourism water (l/little)	300	300	400	400	400	500
Peak factor						
Domestic/public water	1.2					
Tourism water	1.57					
NRW (%)	50	50	50	40	30	15
Daily average water supply(m ³)	850	1,140	2,950	4,710	5,574	6,000
Daily maximum water supply (m ³)	1,083	1,526	4,022	6,082	7,160	8,000

Table 2 Scope of Work of the Project

Description		Contents
1. Construction		
(1)	Raw water intake facilities	1,100 m ³ /d x 8 wells (including one test well constructed in the basic design study), including approximately 4 km raw water conveyance pipes (300 mm DI).
(2)	Water treatment plant	Design capacity 8,000 m ³ /d, including receiving well, oxidation tanks, filter units, chemical facilities, clear water reservoirs, and chlorination facilities.
(3)	Elevated water tank	One elevated water tank to convert the system to gravity.
(4)	Pumping station	Clear water pumping station to the proposed elevated water tank.
(5)	Power generation facilities	Combined power supply system of the EDC and generation systems.
(6)	Transmission pipelines	500 mm DI with length approximately 4 km.
(7)	Distribution network	50 to 450 mm (uPVC 50 to 200 mm, DI for 250 mm or larger) with a total length of approximately 26 km.
(8)	Workshop	For O&M for the procured items and for manufacturing service pipe materials.
2. Rehabilitation		
(1)	Existing distribution network	Existing pipe from diameter 75mm to 450 mm with a total length of approximately 6 km.
3. Equipment procurement		
(1)	Water meters and tools for O&M	4,000 flow meters with appurtenances and tools for facilities/equipment to be constructed.
(2)	Laboratory equipment	Water quality analytical equipment including pH, iron, manganese, residual chlorine, glassware, chemicals, furniture, etc.
(3)	Office management equipment	7 sets of computers required for accounting and customer management
4. Soft Component		
(1)	Training for O&M for the water supply facilities/equipment.	
(2)	Training for organizational strengthening.	
(3)	Support for public education.	

The total duration of the Project is estimated to be 25 months including 7 months for detailed design, 3 months for bidding and tender evaluation, and 15 months for procurement and construction. The total Project cost is estimated to be 1,663 million Yen. The expenses to be borne by GOJ and RGC respectively are 1,640 million Yen and 23 million Yen.

The Project is designed to meet the fundamental development challenges of reducing poverty and improving the quality of life through providing a safe water supply, thereby contributing to the goal of SEDP II. The Project will provide a new water supply system to replace the existing deteriorated and unsatisfactory scheme, and will comprise the development of new groundwater sources; the construction of water treatment facilities, transmission pipeline, and distribution network; rehabilitation of the existing deteriorated distribution network; and procurement of the necessary equipment for the operation and maintenance of the constructed/rehabilitated facilities. In addition, the proposed soft component program aims to support organizational strengthening in the specific fields of technical and managerial issues, as well as to provide basic water supply and hygiene education to the communities in the study area such that they will become aware of the benefits of the new scheme and be willing to pay the water tariff. The soft component program will be conducted in close cooperation with the

“The Project on Capacity Building of the Water Supply System in Cambodia” being implemented under a technical cooperation program by GOJ.

The operation and maintenance cost for the Project should be recovered through the water tariff, assuming the current water tariff and collection ratio remain unchanged, and the electricity cost is maintained within a moderate and acceptable level.

The major benefit that the 8,000 m³/d water supply system Project will bring to the population in the service areas of Siem Reap town is a guaranteed safe and stable continuous 24 hour water supply. The population served will increase from the present 3,185 to 26,000 residents in the service areas by year 2008, which is equivalent to improving the water supply coverage of residents from 10 to 65 percent and the water supply coverage of tourists from 10 to 40 percent by 2008. The direct benefits will include an improvement in the health status and quality of life of the people of Siem Reap town, particularly by reducing water related diseases such as diarrhea and cholera. The piped water supply will also reduce the time presently taken by women and children to carry water. Over time, the tourism industry will also be stimulated and promoted to contribute to the stabilization of the region’s economy, and the provision of enhanced water supply will assist in this development.

On the assumption that drawdown is proportional to the distance from the well and that each well in a multiple production wells is pumping at the same rate, the predicted drawdown of the groundwater level resulting from the groundwater development of the 8,800 m³/d capacity is calculated to be less than 1 mm at the Angkor Heritage site or a 7.5 km radial distance from the proposed well locations. In the F/S, a computer simulation concluded that the drawdown of the groundwater level for a total pumpage of 12,000 m³/d continuing for five years would be within acceptable levels and would not result in serious land subsidence to the Angkor Heritage site. Both the earlier and the recent results indicate that the influence range of the drawdown of groundwater level resulting from the increased abstraction under the Project will not give rise to land subsidence at the Angkor Heritage site.

The Project aims to meet the existing shortfall in supply immediately after the construction of the Project facilities, thereby meeting the fundamental development challenges of improving the quality of life of the residents in the service areas, and supporting the policies set out in SEDP II. However, the capabilities of the existing staff of the Siem Reap Water Supply System (SRWSS) are lacking both in terms of numbers and experience to enable the new water supply scheme to be operated and maintained effectively. It will be necessary for RGC to provide sufficient budget to increase the required manpower to enable the skill-base to be strengthened through the training activities under the proposed soft component. The Project will result in many benefits in the project area and provided that the abstraction of groundwater is maintained within the design capacity, the impact on the Angkor Heritage will be minimal. Consequently, it would be extremely significant and highly appropriate to implement the Project with grant aid assistance from the Government of Japan.

To achieve the objectives of the Project and to maximize the benefits, it is recommended that the following measures be taken by RGC.

The development of tourism facilities is at present only some 2 km south of the Angkor Heritage. RGC should enact the “Water Law” as soon as possible and impose an additional legal control on the

groundwater development in Siem Reap town as necessary.

The rehabilitated monitoring facilities for groundwater level and land settlement must be maintained properly with the allocation of sufficient budgetary and manpower resources to enable continuous monitoring to take place so as to maintain a continuous check on the possible impact of the further development of groundwater sources.

RGC concerned agencies for the Project, including the Ministry of Industry, Mines and Energy (MIME), Siem Reap Province, Authority for the Protection and Management of Angkor and the Region of Siem Reap (APSARA), should collect and analyze the data from the monitoring facilities. Proper corrective measures and actions should be taken if the monitoring data indicate an adverse impact is occurring.

The project cost to be borne by RGC, including those costs for land acquisition, investigations for abandoned mines and buried archaeological remains, dispatch of the Project Team organized under MIME, increased personnel necessary for the Project implementation, construction of gates and fences, power distribution to the proposed water treatment plant site, etc., should be budgeted and disbursed without delay to enable the Project implementation schedule to be met.

RGC should get required approvals for construction of the project facilities including EIA clearance in accordance with the relevant laws and regulations in Cambodia without delay to enable the Project implementation schedule to be met.

The Project Team organized exclusively under MIME to supervise the Project implementation should be trained to understand the Project components and to acquire the necessary skills for proper operation and maintenance of the Project facilities.

RGC should prepare an installation plan for the consumer flow meters to be procured under the Project and install them as planned by the end of 2008.

In close cooperation with the “GMS: Mekong Tourism Development Project” financed by the Asian Development Bank (ADB), RGC should take all necessary measures to cope with the increase of wastewater discharges to public water bodies that will arise as a result of the water supply Project.

Collections under the water tariff should be maintained at the appropriate level to ensure that the water supply entity can operate on a sound financial basis.

MIME should prepare a replacement and refurbishment plan for those existing distribution pipelines that will not be replaced under the Project, so that NRW can be reduced as projected in the Basic Design and so that financial targets can be met and a sustainable water supply operation achieved in the target year 2008.

BASIC DESIGN REPORT

THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY SYSTEM IN SIEM REAP TOWN IN THE KINGDOM OF CAMBODIA

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ABBREVIATIONS

ACP	:	Asbestos Cement Pipe
ADB	:	Asian Development Bank
APSARA	:	Authority for the Protection and Management of Angkor and the Region of Siem Reap
B/D	:	Basic Design
CDC	:	Council for Development of Cambodia
DI	:	Ductile Iron Pipe
EDC	:	Electricite du Cambodge
EIA	:	Environmental Impact Assessment
F/S	:	Feasibility Study
GOJ	:	The Government of Japan
HRD	:	Human Resource Development
IEIA	:	Initial Environment Impact Assessment
MIME	:	Ministry of Industry, Mines and Energy
MIS	:	Management Information System
MOE	:	Ministry of Environment
NPRD	:	National Programme for The Rehabilitation and Development of Cambodia
NRW	:	Non Revenue Water
PEO	:	Provincial Environment Office
PPWSA	:	Phnom Penh Water Supply Authority
PVC	:	Polyvinyl Chloride Pipe
RGC	:	The Royal Government of Cambodia
SEDP II	:	Second Five Year Socioeconomic Development Plan 2001-2005
SRWSS	:	Siem Reap Water Supply System
TIS	:	Thai Industrial Standards
US\$:	United States Dollar
WB	:	World Bank
WTP	:	Water Treatment Plant

Chapter 1

Background of the Project

Chapter 1 Background of the Project

The main infrastructure in the Kingdom of Cambodia (hereinafter referred to as “Cambodia”) was constructed during the colonial period of France. Operation and maintenance of the facilities was not properly conducted for a long time due to the civil war. Only 5.8 percent of the population of Cambodia has currently access to a safe and clean drinking water provided by piped water supply system. Approximately 40 percent of the population use shallow dug wells and 28 percent rely on untreated surface water from rivers and lakes.

The town of Siem Reap with a population of over 110,000 is situated approximately five kilometer south of the Angkor Heritage. More than 500,000 tourists visit the city yearly. With only 10 percent of the population in the study area being provided with a piped water supply, basically in Siem Reap Town, there is a high incidence of water-related diseases. The existing water supply system has a capacity of 1,400 m³/d, but the water treatment facilities have deteriorated and cannot cater to the increasing water demands. Many hotel businesses are operating and a sharp increase of the tourism industries results in uncontrolled abstraction of groundwater sources in the area.

Under the circumstances mentioned above, the Japan International Cooperation Agency (hereinafter referred to as “JICA”) conducted “The Study on Water Supply System for Siem Reap Region in Cambodia” over the period of 1996 to 2000 under a technical cooperation of the Government of Japan (hereinafter referred to as “GOJ”) to formulate a master plan for the water supply system for Siem Reap Town by undertaking a detailed analysis on population projection, water demand projection, selection of water sources, etc. The Master Plan (hereinafter referred to as “M/P”) proposed as an urgent plan for the water supply scheme which included 10 groundwater source developments with a total design capacity of 8,000 m³/d and the Feasibility Study (herein after referred to as “F/S”) was carried out. In the F/S, the preliminary design and the magnitude of funding were identified. It was concluded that the project was feasible in terms of technical, economical/financial, and environmental aspects, having minimum negative impacts especially on lowering of groundwater table and land subsidence in the study area due to the groundwater source development under the project.

At present, the Royal Government of Cambodia (hereinafter referred to as “RGC”) is implementing the Second Socio-Economic Development Plan 2001-2005 (hereinafter referred to as “SEDP II”) to promote the development of physical infrastructure which is inadequately developed and maintained. In the water and sanitation sector, SEDP II targets an 87 percent of the urban population to have access to safe water in the year 2005, within the SEDP II term, from an estimated 48 percent coverage in the year 2000.

In the light of the policy of SEDP II and the recommendations made in the F/S, RGC requested a grant in aid program to GOJ to implement the Project for Improvement of Water Supply System in Siem Reap Town (hereinafter referred to as “the Project”) in January 2000. In response to this request by RGC, GOJ agreed to conduct a basic design study (hereinafter referred to as “B/D”). In fulfillment of this agreement, JICA implemented the B/D in March 2003 as shown in Appendix 1, 2, and 3 in close cooperation with the concerned agencies of RGC. The Basic Design Study Team (hereinafter referred to as “The Study Team”) was dispatched four times from March 2003 through August 2003 to undertake field survey and to explain the draft design report in early October 2003. This basic design report includes the basic concept, size, contents, and the related items of the Project.

Chapter 2

Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

RGC is currently implementing the SEDP II in close linkage to the National Poverty Reduction Strategy (NPRS). The main objectives of the SEDP II are to achieve i) a rapid and broad-based sustainable economic growth and increase the accessibility of the poor to economic activities, ii) enhancement of human resources by improving the access of the poor to education, health, water and sanitation, power, credit, markets, information and appropriate technology, and iii) provision of safety nets for the socio-economically disadvantaged sectors through improved accessibility to the benefits of economic growth. In the water and sanitation sector, the RGC is committed to achieving the long-term goal of providing access to clean drinking water and environmental sanitation for the entire population, and aims at providing clean water to 87 percent of the urban population by the end of 2005, compared to an estimated coverage of 48 percent in 2000.

RGC requested GOJ to conduct the Project as shown in Table 2.1 which aims to construct a water supply system with a nominal design capacity of 8,000m³/day by development of groundwater source to ensure the supply of safe and stable water in the Siem Reap town in accordance with the said policy of SEDP II. The scope of the Project is slightly changed in service area accordingly to the site survey conducted by the Study Team in the same line with the original project concept, referring to the Minutes of Discussions as attached in Appendix 4. The following shows the applied design concept for the Project.

The objective of the Project is to improve water supply coverage from 10 percent of the current coverage level to 65 percent by using groundwater source by providing a direct benefit of water supply with the 26,000 population out of the estimated 40,000 population in the service areas in target year 2008. As a result, the Project brings about a safe and stable water supply in the Project area by operating the proposed water supply system to be constructed.

The Project includes a development of the total water supply system in Siem Reap Town with a nominal design capacity of 8,000 m³/day, consisting of the components shown in Table 2.1.

Table 2.1 Comparison Between the Original Request by RGC and the Proposed Scope of Work

Descriptions		Original Request by RGC	Proposed Scope of Work
1. Construction			
(1)	Raw water intake facilities	800 m ³ /d x 10 wells, including conveyance pipes.	1,100 m ³ /d x 8 wells (including 1 well constructed under the Basic Design Study) and 4.0 km of raw water conveyance pipes (300 mm DI).
(2)	Water treatment plant	Receiving well, distribution tank, chlorination equipment.	Oxidation tanks, filter units, and chemical facilities are added to the request due to iron removal process is required.
(3)	Elevated water tank	Not included due to pumping system was adopted.	One elevated water tank is employed to improve the system to gravity system.
(4)	Pumping station	Pumping station.	Clear water pumping station to the proposed elevated water tank.
(5)	Power generation facilities	L.S.	Combined system of the EDC and generation systems.
(6)	Transmission pipelines	Pipes. From dia 75mm to 500 mm with a total length of 17,025 m. (Ductile iron pipe for pipe size not less than 200 mm, uPVC pipe for pipe size less than 200 mm)	A total pipe length will be 4,050 m of transmission pipe (500 mm DI)
(7)	Distribution network	uPVC pipes from dia 50 to 75 mm with a total length of 6,200 m	A total pipe length will be 25,843 m of distribution pipes (50~450mm). (DI for pipe sizes 250 mm or larger and uPVC for pipe sizes 200 mm or smaller)
(8)	Workshop	Not included.	Added to secure proper O&M for the procured items.
2. Rehabilitation			
(1)	Existing distribution network	Existing pipe from dia. 100 to 400 mm with a total length of 6,310 m.	Existing pipe from 75 to 450 mm with a total length of 6,060 m. Pipe materials are same as the transmission/distribution pipes.
3. Equipment procurement			
(1)	Tools for O&M	Tools for facilities to be constructed.	Same as Original Request.
(2)	Water meters with appurtenances	4,797 including installation	4,000, procurement only (installation will be done by RGC).
(3)	Laboratory equipment	Not included.	Water quality analytical equipment including pH, iron, manganese, residual chlorine, glassware, chemicals, furniture, etc.
(4)	Office management equipment	Not included.	7 sets of computer units required for accounting and customer management
4. Soft Component			
(1)	Assistance for management	Not included.	Supporting for improvement of capacity building of the SRWSS.
(2)	Assistance for engineering	Technical assistance for O&M for the facilities to be constructed.	Same as Original Request.
(3)	Assistance for public education program	Not included.	Public education for the people of Siem Reap.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Design Concept

The target year for the Project is set to be in the year 2008. Originally, RGC proposed 2006 as the target year in their request to GOJ in January 2000 based on the F/S. However, taking into consideration the entire project implementation schedule including the detailed design, selection of contractor, and the construction works, the Project will be completed in January 2006, at the earliest. The Project should then cover the increasing water demand in the short term after construction of the Project facilities to urgently cope with current shortage of water supply in the study area. Therefore, the target year for the Project has been moved to the year 2008.

The total Project service area shall be of 425 ha. This is based on the RGC original 345 ha service area prepared in the F/S and the proposed additional service area of 80 ha raised during the first field survey in Cambodia. The proposed service areas are situated north western areas along the national road No. 6 and in the Kokchak Commune. At present, the population in the proposed areas increased rapidly due to increase in the tourism industries and change of land use plan from the military zone to residential zone.

The development of tourism industries results in rapid increase of water demand in the area. However, the priority for water supply shall be given to the domestic and public water users rather than tourism industries to cope to the fundamental development challenges of reducing poverty and improving the quality of life. Further, the total water demand including tourism industries is way beyond the design capacity with groundwater source proposed in the F/S. A large scaled development scheme shall be considered if the project fully covers the water demand including tourism industries, taking water sources from not only groundwater but also surface water sources in the region. A comprehensive water supply development scheme in the Siem Reap Town shall be developed based on a regional development plan.

(2) Design Policy on Natural Conditions

The proposed Project area is a tropic zone with a high temperature and humid. A yearly total precipitation is approximately 1,500 mm, which is similar to average cities in Japan. However, most of precipitation is concentrated in a rainy season from May to October. The recorded strongest wind speed is 26 m/s and will be considered in structural design for the Project. Cambodia is situated on a stable Eurasian Plate. Therefore, earthquake loads will be ignorable in the design for earthquake resistance. Moreover, lightning protection and earth systems will be provided in the building and structures taking into consideration the weather conditions in the proposed Project area.

(3) Design Policy on Socio-economical Conditions

In Cambodia, public organizations adopt a five-day work week, while private organizations adopt a six-day work week. Cambodia has more than 20 days national holidays in a year. National holidays are observed more than three days in the middle of April and from the end of October to middle of November. In case national holidays fall on Saturday or Sunday, the following Monday is considered holiday. In labor laws, weekly working hour is stipulated to be within 48 hours. In preparing the implementation schedule for the construction works, these circumstances will be taken into consideration.

(4) Design Policy on Legal and Institutional Aspects

Article 44 of the Royal Decree 0399-01, for “Expropriation of Land” stipulates the required process for land expropriation. An implementation agency shall consult with the Ministry of Economy and Finance and organize a committee. The committee shall negotiate with the related land owners and estimates the budget for the land acquisition. The proposed water treatment plant site is situated in a zone for “Protected Cultural Landscapes”. The area should be protected on account of its traditional appearance, land use practices, varied habitats, historic building, or man-made features from the past or of recent origin, that contributes to the cultural value or reflects tradition life styles and patterns of land use.

(5) Policy on Hiring the Local Materials and Engineering Firms

The Cambodian construction industry is still a small business. Due to its weak technological background, the general contractors can not fully bear the responsibilities for construction of the Project facilities. Only pipe works in the proposed Project may be applicable for the local contractor who may have actual experiences on pipe installation works with the Japanese prime contractor in the Japan’s Grant Aid Project in Phnom Penh. It is desirable to make best use of the local contractors to promote technical transfer from the Japanese prime contractor and local construction materials that may contribute to the reduction of construction cost.

(6) Implementing Agency’s Capability on Project Management and O&M

The manpower of Siem Reap Water Supply System (hereinafter referred to as “SRWSS”) has only 12 personnel including permanent and casual. They have insufficient experiences on proper management of the proposed water supply systems. Their educational background is not enough to handle the new water supply business. To support the capacity building of the Siem Reap Water Supply System, some measures for capacity building should be taken in the Project Implementation.

(7) Grade of Facilities and Equipment

Simple concept in the design of facilities and equipment will be applied for easy operation and maintenance. In case errors occur, the system should be kept in operation to produce a safe drinking water in short term period. Should some equipment be planned to be procured from Japan or the third country, the selected equipment can be maintained locally in Cambodia.

(8) Construction Methods, Procurement, and Implementation Period

In accordance with the design policy on natural and socio-economic conditions, quality and safe management will be considered in the Project. In case of a need to protect foreign tourists and to minimize the construction schedule, night works will be considered and sufficient number of groups will be planned.