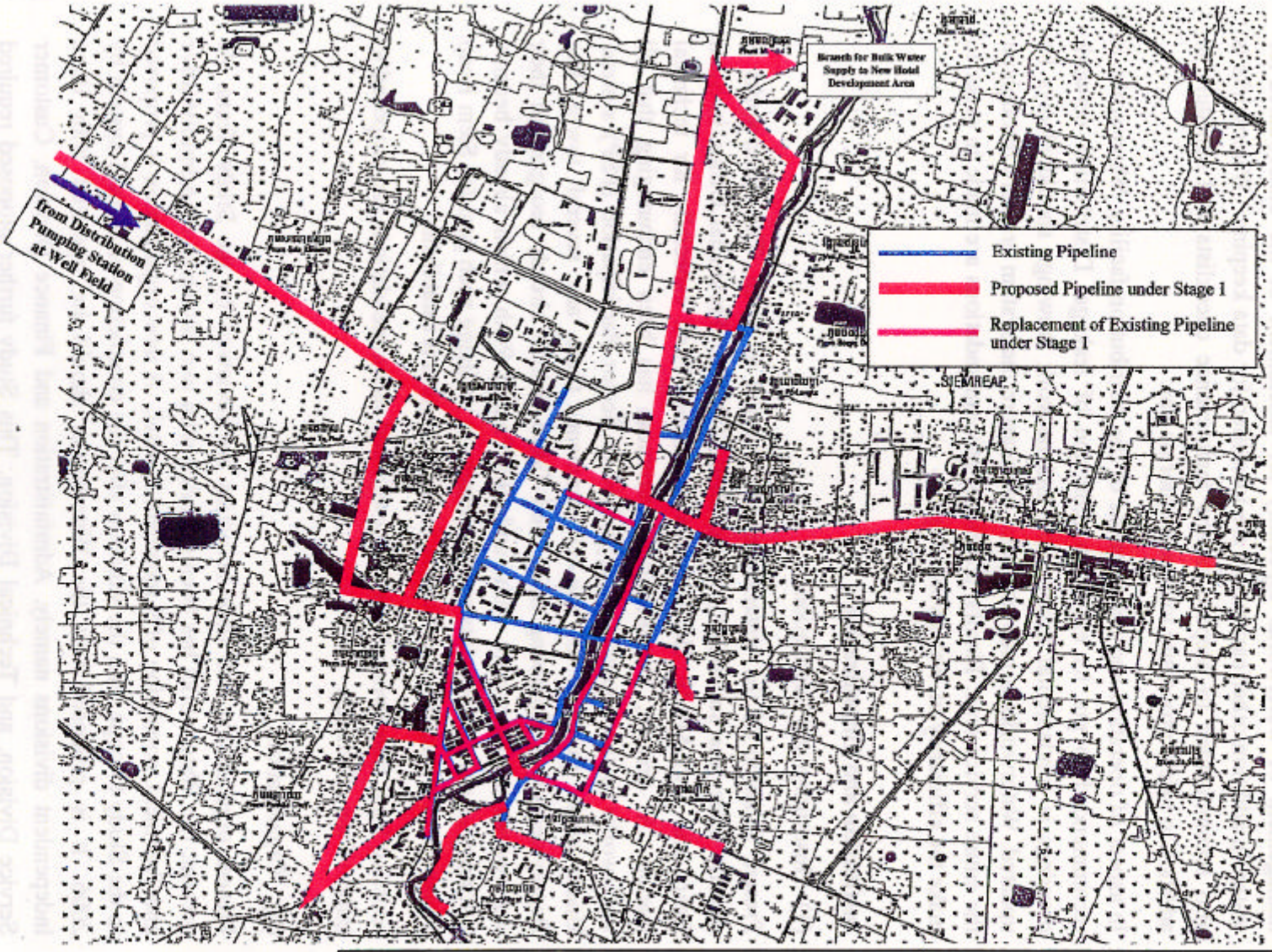

The Study on Water Supply System for Siem Reap Region in Cambodia	Figure 5.3.4 Stage 1 Distribution Network
Japan International Cooperation Agency	

The most important thing in operation of the production facility is keeping record of water quantity produced every day. These records are indispensable to evaluate management of waterworks especially for assessment of the unaccounted-for water. In addition other parameters are identified for data keeping. Waterworks is also recommended to prepare routine maintenance checklists and schedule in addition to safety procedure to handle chlorine gas.

In aspect of operation and maintenance of the distribution facility, Waterworks is recommended to put its effort on reduction of leakage. Distribution network drawings is fundamental information and network drawings should always be updated. Waterworks is recommended to measure the system pressure throughout the entire service area. Finally, additional recommendations are made in order to make the efficiency of Waterworks high.

5.4 Institution and Organization

(1) Institution and Legislation

Present situation of the waterworks was studied in detail. The Waterworks is directly under the supervision and control of MIME Provincial Office in Siem Reap, and also MIME Headquarters in Phnom Penh especially for technical matters. At present, Cambodian Government has been encouraging that all waterworks in the country employs Private Sector Participation (PSP) system. Under such guideline of the Government, there are several towns like Banteymeanchey, Kompong Speu, and Takeo, which already reorganized their waterworks to the private units, and like Phnom Penh which already became autonomous unit. Constraints and challenges in realizing such goal for Siem Reap Waterworks are analyzed and a plan for coordination is established.

Existing legal framework is also reviewed and recommendations are proposed to improve the efficiency.

(2) Organization

Present organization and their activities are reviewed by the Study Team. At present, the Waterworks has been operated with two divisions of Administrative and Technical, consisting of 9 members in total. A new organization is proposed in the Study to cope with the situation after the completion of Stage 1 system by 2006. It is proposed that the Waterworks should be operated with three independent divisions namely, Administration and Finance Division, Customer Service Division, and Technical Division. This Study further proposed required sections under each division with their specific job responsibility. Total employees number is proposed to be 19 by 2006. Work description for each staff is proposed along with their hiring schedule.

(3) Training

The training will be one of fundamentally important matters for improvement and promotion of the staff abilities. To meet such purpose, the following training classified from the contents, methods, timing, and so on proposed by the Study.

- Training for every split business hierarchy
- Training for practical business/subjects
- Training for specified items
- Training by dispatching/sending to other places or by invitation of lecturer
- Training within workshop/working place (on-the-job training)
- Support for self-study

Complete set of the training subject for different address group, along with timing, opportunity, and period of training is described in the Study.

5.5 Cost Estimation and Implementation Plan

(1) Cost Estimation

Base year for the cost estimation is 1999, with an exchange rate of 1 US$=3,800 Riel and 1 US$=120 Yen. Unit costs are collected from various sources to reflect actual situation. Cost is estimated into two categories, namely, project cost and operation and maintenance cost.

The construction costs and total project costs are estimated as about 11.32 and 16.3 million US Dollars, respectively. The estimated project costs including the related costs as well as cost allocation of foreign and local currency are summarized in Table 5.5.1.

Table 5.5.1 Estimation of the Project Cost

(Unit: US$1,000)

	Description	Foreign Currency	Local Currency	Total of Stage 1 (Year 2006)
A	Construction Cost	10,685	635	11,320
B	Land Acquisition Cost	0	250	250
C	Administration Cost (2% of A)	0	226	226
D	Engineering Services (15% of A)	1,698	0	1,698
E	Physical Contingency (10% of A+C+D)	1,238	86	1,324
F	Price Contingency (10% of A to E)	1,362	120	1,482
	Total	14,982	1,317	16,300

The operation cost includes power cost, chemical cost, and personnel cost. Maintenance cost is estimated as 1% of the construction cost.

Operation and maintenance costs (including not only the new system but also existing facilities) of system from year 2002 to year 2006 (Stage 1) are estimated as shown Table 5.5.2.

Table 5.5.2 Estimated Annual Operation and Maintenance Costs

Description	Unit	2002	2003	2004	2005	2006
Power Cost	US$/year	121,090	135,645	154,857	166,436	186,855
Chemicals Cost	US$/year	5,436	8,122	11,262	14,011	16,080
Personnel Cost	US$/year	39,000	41,400	42,600	45,000	47,400
Maintenance Cost	US$/year	113,196	113,196	113,196	113,196	113,196
Total	US$/year	**278,722**	**298,363**	**321,915**	**338,643**	**363,531**
Unit Power Cost	US$/$m^3$	0.162	0.120	0.098	0.084	0.082
Unit Chemicals Cost	US$/$m^3$	0.007	0.007	0.007	0.007	0.007
Unit Personnel Cost	US$/$m^3$	0.052	0.037	0.027	0.023	0.021
Unit Maintenance Cost	US$/$m^3$	0.152	0.100	0.072	0.057	0.050
Total	US$/$m^3$	**0.373**	**0.264**	**0.204**	**0.171**	**0.160**

(2) Implementation Plan

The proposed implementation schedule including budgetary arrangement, detailed design, tending and construction, as well as training and institutional development etc. is summarized in the Figure 5.5.1.

Project costs (construction costs and related costs) disbursement for Stage 1 is also carried out considering the implementation schedule of the project, and the results are shown as Table 5.5.3.

Table 5.5.3 Project Costs Disbursement for Stage 1

(Unit: US$1,000)

Year	Annual Disbursement	Ratio
2000	591	3.6%
2001	7,759	47.6%
2002	7,950	48.8%
Total	16,300	100%

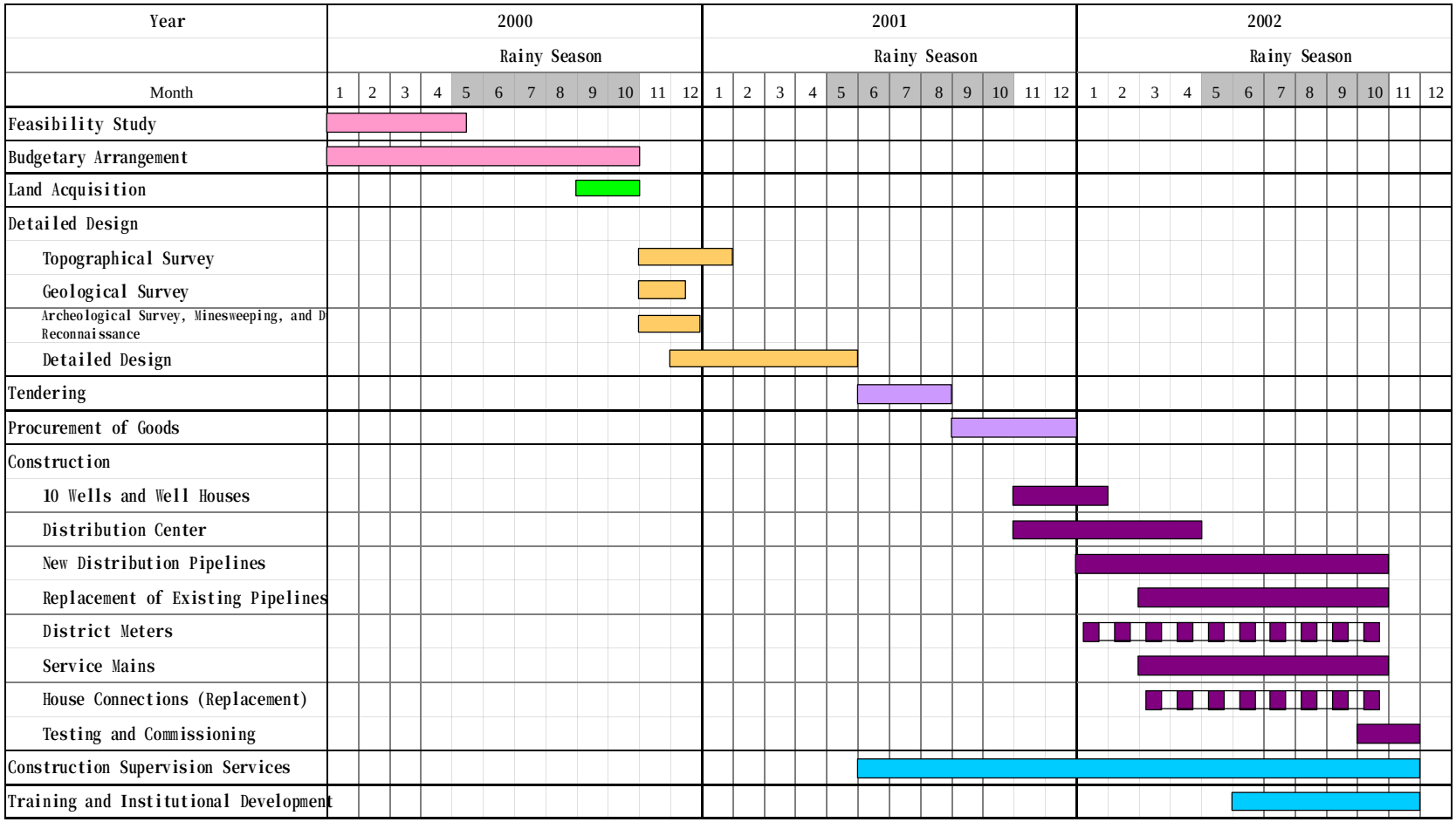

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Figure 5.5.1
Implementation Schedule for Stage 1

5.6 Economic and Financial Analysis

(1) Introduction

The viability of the proposed project is examined from the two points of view: (1) economic aspect and (2) financial aspect. The financial simulation of the proposed project is conducted through a financial analysis simulation model.

(2) Economic Analysis

The methodology of economic evaluation is the same as done in the Master Plan. Only Stage 1 cost is considered when calculating economic cost. In addition, a sensitivity test is introduced for the certain aspects.

The evaluation factors were EIRR of 9.2%, B/C of 0.94 and NPV of US$ -0.92 million. The EIRR was slightly lower than the opportunity cost of capital of 10% in spite of the fact that the EIRR of the Master Plan was 10.5%. This is because the facilities designed in the Feasibility Study include a part of prior investment. In the future, thus, the EIRR is expected to be over 10% after the Stage 2 is implemented.

A case with long implementation period and increment of future water demand growth has risks in terms of judgment on project viability. It is customary, therefore, to test the results of economic analysis for sensitivity to variations in certain important inputs. The test is made for the variations in ±10% of the cost and benefit with respect to evaluation factors of the proposed project. Then, there are nine cases under these variations. The results of the sensitivity test are shown in Table 5.6.1. Accordingly, the estimates of cost and benefit should be reconsidered with prudence at the implementation stage.

Table 5.6.1 Results of Sensitivity Test

	Cost	Benefit	EIRR (%)	B/C	NPV (US$1000)
1.	Original Case	-	9.2	0.94	-922
2.	-	10% Decrease	7.9	0.84	-2,294
3.	-	10% Increase	10.4	1.03	449
4.	10% Increase	-	8.1	0.85	-2,323
5.		10% Decrease	6.9	0.94	-3,695
6.		10% Increase	9.2	0.94	-952
7.	10% Decrease	-	10.5	1.04	479
8.		10% Decrease	9.1	0.93	-892
9.		10% Increase	11.7	1.14	1,851

(3) Financial Analysis

The financial simulation is based on a financial analysis model, which shows financial simulations under various financial conditions and assumptions. Through these simulations, the model suggests the relation between the new water tariff including the new installation charges and the financial management conditions that were adopted by this Feasibility Study. In order to assess the financial implications and long-term viability, all-important elements of the project was clarified as well.

The proposed project in the Feasibility Study was evaluated in the same manner as done in the Master Plan. The financial evaluation results were a B/C of 0.33, NPV of US$ -10.98 million, and FIRR of -2.7%. The figures of B/C and NPV were discounted at 10%. These figures indicate that the proposed project is not viable from the financial viewpoint.

Against this negative condition, some countermeasures are proposed for making the project viable from the financial viewpoint. The following cases are considered.

Case 1: The revenue of water sales is increased by means of raising water tariff to 3.3 times more than the present one.

Case 2: More than 86% of the initial investment is covered by subsidy of the government or grant from foreign donors.

Case 3: Combination of the above measures.

For recommendable financial plans, a financial simulation was done applying a financial analysis model. In the model, the management of the water supply services is simulated as a financially autonomous entity. Among various countermeasures possible, the following financial plans were adopted for financial simulation after carefully selecting simulation assumptions.

Financial Plan 1: In this case, 30% of the total investment costs is procured from loan of financial organization and 70% from grant of foreign countries and central governments. In addition, the water tariff is set at 50% higher than the present rate.

Financial Plan 2: In this case, the entire finance for initial investment is procured as grant from foreign countries and central governments. The water tariff is set at the present water rate.

In the financial plan 1, the Waterworks will have a net loss in the target year of 2006, although their operating results record net gains. Since the amount of net loss decreases year by year, the cash balance is expected to return to black in 17th year (2018). After that, the accumulated deficit will reduce and return to break-even in 24th year (2025).

In the financial plan 2 as well, the Waterworks will have a net loss in the target year of 2006, although their operating results record net gains. However, the simulation makes it clear that the cash situation of the plan 2 is much more positive than that of plan 1 during the starting period and especially after 2007, the end of grace period of the loan in the plan 1. The cash balance is expected to return to black in 17th year (2018) and the accumulated deficit will reduce and return to break-even in 27th year (2028).

Considering the financial situation of consumers and World Bank guideline for water tariff, financial plan 2 is favored after making various analysis and comparison.

5.7 Environmental Considerations

In the Feasibility Study stage, an Environmental Impact Assessment (EIA) for the priority project was carried out based on the scope of EIA prepared earlier. In addition, future anticipated water quality was also reviewed.

(1) Groundwater Level

Excessive lowering of groundwater table may reduce the yield of other wells operating nearby and may ultimately reduce the yield of the wells under the Project if the recharge is less than abstraction. In the additional computer simulation, it was found that there would be only concentrated drawdown near each well. So, there is little impact in the surrounding areas. However, continuous monitoring has to be done to check drawdown allowable limits.

Another possible impact could be the degradation of water quality caused by groundwater abstraction. Since the capacity of the proposed well field is lower than the calculated yield, this possibility is fairly low. However, water quality should be monitored continuously throughout the life span and detail study should be done before implementation of Stage 2 project.

(2) Land Subsidence

Land subsidence may bring about the transformation and functional disorder of various structures, and the spread of flood damage area caused by the decrease in drainage capacity. An excessive land subsidence may cause structural damage to buildings, airport, and Angkor heritage. Based on the results from the pilot well operation, the result of a computer simulation showed that there would be no significant land subsidence around the heritage area. However, continuous monitoring with additional stations should be done to conceive succession for land subsidence.

(3) Land Acquisition

The land requirement for the Project includes one plot of 10,000 m^2 and 10 plots of 50 m^2. All pipelines will be placed under the road so no permanent land acquisition is necessary. Also, all wells will be located on public land. As indicated in the IEE, there is no resettlement problem anticipated in the Project. A one hectares land acquisition is required for the disinfection and distribution facilities. The location was selected within paddy cultivation land to eliminate the impact of resettlement. Proper compensation should be paid for land acquisition.

(4) Wastewater Generation

Any water supply project increases the domestic wastewater. If not disposed properly, benefits from safe water supply may disappear and may constitute a threat to public health. Based on maximum water supply capacity, wastewater generation and pollution load were calculated. Proper arrangement for wastewater disposal is essential to get maximum health benefit from a water supply project. A brief future wastewater disposal plan was proposed in the Master Plan Study.

(5) Economic Activity

Easy access to water does, in one hand, benefit the economy by reduced mortality and increase of economic time. On the other hand, water tariff may put some pressure on personal economic condition. However, in the present case, detailed calculation showed that the proposed water tariff is less than the present economic water cost.

Also, persons involved in shallow well digging and maintenance may have to change their profession. Detail investigation showed that since the major market for the well construction activities is now outside the town center, introduction of piped water supply system will not create any significant impacts on these peoples.

(6) Cultural Values

With the easy water availability, tourism potential will increase. This may put extra pressure on the precious cultural property of Angkor heritage although increase in tourism will benefit the local economy. However, this Study estimates less visitors than APSARA safe limiting value with present infrastructure.

(7) Future Water Quality

Area adjacent to the proposed well field is mainly agricultural area. According to the Department of Agriculture, there is no risk of contamination from the irrigation excess. Detail investigation showed that the low coverage of artificial

fertilizer and pesticide, and low level of application amount, will not cause possible degradation of water quality in future.

5.8 Conclusions and Recommendations

(1) Conclusions

1) Technical Evaluation

After implementation of the Stage 1 Project, service area will be 345 ha and served population will be 25,500 people in 2006. No special technologies are required for the construction works of the proposed water supply facilities. The proposed groundwater based water supply system requires simple operation and maintenance skill. From the results of pumping and quality tests of pilot wells, quality and quantity are confirmed as suitable as a water source.

From the technical point of view, this project is evaluated as viable.

2) Financial Evaluation

Under the conditions that 30% of the total investment costs is procured from loan of financial organization and 70% from grant of foreign countries and central governments, the water tariff is set to 50% higher than the present rate (Financial Plan 1), the cash balance is expected to return to the black in 17th year (2018). After that the accumulated deficit will reduce and return to break-even in 24th year (2025).

In the case that the entire finance for initial investment is procured as grant from foreign countries and central governments, the water tariff is set at the present water rate (Financial Plan 2), the cash balance will return to the black in 17th year (2018), and the accumulated deficit will return to break-even in 27th year (2028).

From the financial point of view, these two financial plans make this project viable. Considering the water tariff, the Financial Plan 2 is recommended.

3) Environmental Evaluation

Groundwater abstraction may cause the land subsidence. From the results of the pumping tests and groundwater simulation, it is confirmed that the planned groundwater abstraction will not cause any serious land subsidence problem (simulation result: land subsidence is less than 1 mm) around the Angkor heritage area.

4) Overall Evaluation

Considering the technical, Financial and environmental evaluations, the Stage 1 project is judged as a feasible project.

After the implementation of Stage 1, people will be able to access the safe water easily. Water born diseases will be decreased. Tourist-related infrastructure will also be improved.

(2) Recommendations

1) Review of Master Plan in Future

The present Master Plan has the time horizon set at the year 2010. For the development of future water supply related infrastructure, a review of the Master Plan is essential. This can ensure the compatible consideration of various changing factors. It is recommended to start this review of the Master Plan Study from 2006.

2) Continuous Monitoring

Groundwater monitoring including additional points should be conducted through the entire service period of the Project. The main objective is to ensure the safety of the famous Angkor heritage. Various types of monitoring are proposed by the Study Team, namely, level monitoring of existing wells, well field and existing monitoring stations, land subsidence monitoring, and water quality monitoring. It is also recommended that further confirmation of groundwater potential should be conducted before the implementation of Stage 2 of present planning.

3) Regulation for Restriction of Groundwater Usage

At present, the major source of water in Siem Reap Town is groundwater. To ensure the renewability of the groundwater resources, this use has to be restricted after the operation of the Project. A legal framework is required for the proper reinforcement. A stepwise approach is proposed in detail to implement.

Future hotel zone locates near the Angkor heritages. Hotels in the future hotel zone will have great water demand. Constructions of deep wells in the hotel zone should be restricted. Water will be supplied from the well field of the Stage 1 Projects by bulk supply.

4) Public Relation and Education on Hygienic Life

In order to get maximum benefit from the water supply system, public awareness is a precondition. Hygiene education should be included in the curricula of school education. Also, hospitals and public health clinics can play a vital role in information dissipation. A coordinated approach on the parts of NGOs is also very effective. Finally, programs in mass media can help in achieving the objectives.

5) Sanitation and Wastewater Control System

Total benefit from a water supply project can not be obtained completely without a proper wastewater and drainage management system. A future wastewater disposal plan is proposed in Section 4.8.3. An immediate attention should be given in order to implement those plans.

6) Action Required for Project Implementation

The following action should be required for project implementation:

- Coordination with Central Government

MIME is recommended to request the cooperation of Central Government for external funding arrangement.

- Coordination with Local Provincial Government

Cooperation of the local provincial government is required for smooth project implementation. MIME is recommended to explain scope of the project and role of the local provincial government not only for the project implementation but also for the sound management of the Waterworks after inauguration of the new system.

- Arrangement for Acquisition of Land Space Required

Land space will be required for well field and receiving well/clear water reservoir. These land spaces should be procured before commencement of civil work. MIME is recommended to make necessary actions for the land acquisition with cooperation of the local provincial government.

- Archeological Survey in the Distribution Center

It is necessary to survey whether a heritage exists or not in the planned distribution center of the 1 ha area and/or the pipe line route. Therefore, various archeological surveys are requested to carry out timely with the cooperation of UNESCO/APSARA and NGOs.

- Coordination with Phnom Penh Water Supply Authority (PPWSA)

Siem Reap Waterworks may need assistance from PPWSA in many aspects such as technical and managerial. It is strongly recommended to keep close relation with PPWSA.