THE KINGDOM OF CAMBODIA

PREPARATORY SURVEY ON BOP BUSINESS ON WATER SUPPLY SYSTEM FOR DAILY LIFE IN RURAL AREA (SUMMARY)

July, 2015

Japan International Cooperation Agency (JICA)

Kisui Water Treatment Japan, Inc.

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The Kingdom of Cambodia, Preparatory Survey on BOP Business on Water Supply System for Daily Life in Rural Areas - Final Report (Summary)

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Chapter 1 – Executive Summary

1.1 Background of Proposed Project

- In the “Rectangular Strategy” for key national development, the Kingdom of Cambodia lists the improvement of potable water supply systems as an important issue. The national water supply and sanitation policy aims to realize a system for supplying safe potable water to all residents in rural areas by the year 2025.
- Efforts are being made with the development of water infrastructures in rural areas to expand the water supply system by implementing a system for licensing water supply projects to intermediate private companies that have not been able to set plans for development due to reasons such as cost and human resources. However, in rural areas where the majority of the population consists of poorer people who have difficulty paying for water charges, there are still many regions where there are no water facilities and access to safe water has not been established.
- Under such circumstance, there is a need for a water supply system which is small-scale, dispersed, and capable of being continuously maintained and managed by local residents. However, the cost of such water supply system cannot be expected to be borne by the BOP groups or the local governments of the villages and communes to which they belong.

1.2 Summary of Proposed Project

This proposed project aims to sell and popularize a water supply system through the incorporation of the structure of the following business model which, by simultaneously conducting projects for the middle and upper classes, enables continuation of a project for supplying water to the BOP groups.

[Structure of the Business Model]

(1) Installation of the water supply system will be conducted by a local subsidiary.
(2) A “farm village association” consisting of local BOP groups will be established and receive guidance on how to maintain, manage, and operate the system. Manuals will be prepared as well.
(3) The potable water that is obtained from the water supply system will be “sold” to nearby BOP groups. In order to realize sales to these people with little cash income, measures will be taken to improve their cash income to a level that will allow them to purchase potable water. This will be done by having the local subsidiary purchase products such as vegetables, fish, pork, and handicrafts which are produced in these farming villages. At the same time, guidance on sanitation will also be conducted in order for the people to raise their awareness of safe water.
(4) The local subsidiary will sell the farm village products purchased from the farming villages to the middle and upper classes in urban areas by setting up sales routes and conducting sales.
(5) In addition, by the local subsidiary providing guidance on accounting as well as how to produce and manage potable water, the “farm village association” will eventually become able to independently and continuously manufacture and sell potable water and conduct the trade of farm village products.

(6) Farming villages that have become capable of independently operating business as a “farm village association” will be presented as a “model farming village” to other neighboring villages and communes or districts, etc. in which such villages are contained. Efforts will be made to expand the “farm village association” while teaching know-how by the model farming village accepting training.

(7) With only the flat-rate income of water supply service charges from the “farm village association” and the profit generated from the sales of agricultural products in urban areas, it can be inferred that the local subsidiary will have difficulty maintaining itself unless the number of management associations are increased to a certain extent. Accordingly, similar to the business in Japan, activities will be conducted in parallel for selling water treatment equipment, such as well water filtration devices and rainwater filtration devices, to consumers in demand such as factories and urban industries with the ability to pay. As it will take time to develop a structure for local production, the beginning of the project will start with the development of the sales of compact water purification devices which can be exported.

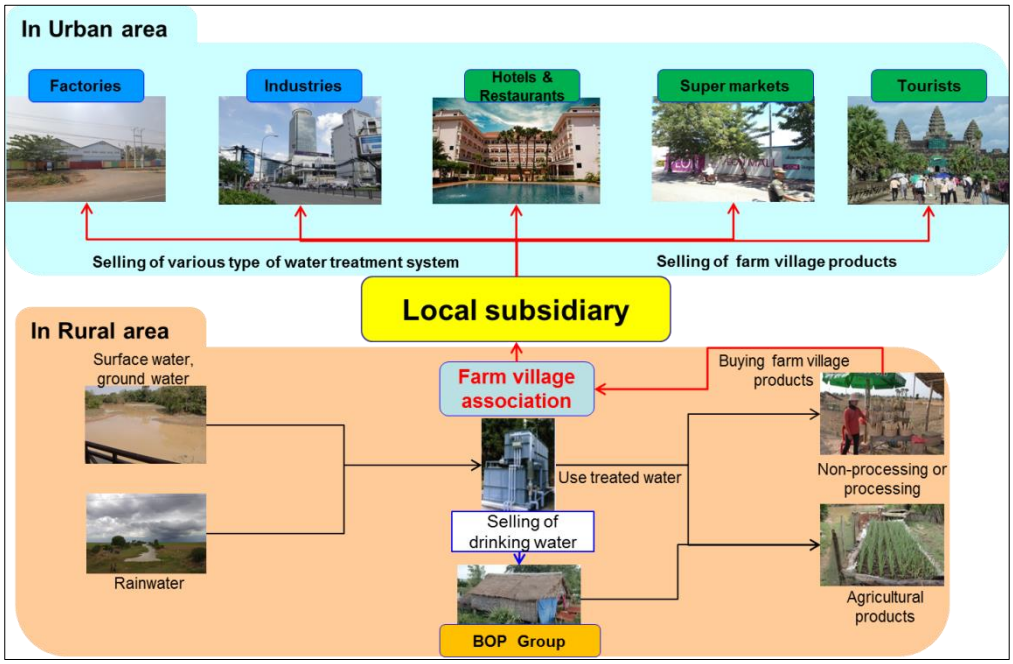

Fig. 1-1 Business Model

1.3 Summary of Survey

1.3.1 Configuration of Survey Team Members

The configuration of the survey team members and the roles of each are as listed below.

KISUI WATER TREATMENT JAPAN, INC.:

: Providing overall supervision, drafting the business model, conducting surveys in general, developing water treatment equipment for local use, preparing manuals

FORVAL CORPORATION (reinforcement member)

: Surveying agricultural situations and markets for vegetables and other products,

communicating with locals, etc.

NPO JAPAN OVERSEAS COOPERATIVE ASSOCIATION OF KYUSHU (reinforcement member)

: Providing operational guidance to management association members, conducting monitoring surveys, etc.

SYUEI MURAMOTO (reinforcement member), KOREHIRO AKAISHI

: Surveying local water quality and water usage environments, developing water treatment equipment for local use

Other External Personnel

: Providing agricultural guidance, instructing experimental cultivation, etc.

1.3.2 Purpose of Survey

The purpose of the survey is, through the establishment of the business model being proposed, to realize a continuous water supply system for daily life and aim to popularize this water supply system as a result thereof. In this survey, upon selecting a farming village to serve as a model, a pilot water supply system with specifications for local use will be developed and installed, a farm village association will be established, and water will be experimentally sold. At the same time, by creating a structure to improve the cash income of the BOP group, the realizability and business feasibility of this business model being proposed will be verified.

1.3.3 Implementation Details of Survey

The survey was implemented with the following steps.

(1) Collecting existing information, surveying existing conditions, and analyzing present situations (preparatory survey)
(2) Conducting basic surveys and preparations for creating a model farming village (Phase 1)
(3) Creating an operational system for the model farming village (Phase 2)
(4) Implementing and verifying operational experiments (Phase 3)

1.3.4 Survey Results

1) Summary of Survey Results

In verifying the realizability of this business model, measures to improve cash income of the BOP group were implemented in the same village as where the pilot water supply system was installed. Whether the proposed business model would function was verified by confirming the following points for determination. Accordingly, the plan was to determine whether there would be a possibility for commercialization.

However though, due to not being able to obtain permission for constructing the pilot water supply system in the originally planned candidate site for the model farming village (Angkor Krau village), as the installation site was switched to a different village (Svay Chek village), there are some items that have not yet been confirmed.

[Points for Determination upon assessing the Possibility of Business Propriety]

(1) To start with, is there even a demand for a water supply system (= demand for safe water) in rural areas?
Further, is the scale (= population) adequate as a market for sales?

(2) Is it possible to develop and construct a pilot water supply system with local materials and construction systems and produce potable water compliant to Cambodian water quality standards? Around how much will the costs involved be?
Further, around how long will it take to recover the costs required for installation?

(3) Through guidance to local personnel including the BOP group, is it possible for them to independently continue the operational activities of maintaining and managing the system together with the business of selling farm village products?

(4) Does the measure for improving cash income of the BOP group seem to be realizable?

(5) Is it likely that the BOP group that has received guidance on sanitation will spend the cash obtained through sales of farm village products, etc. on purchasing water?

(6) In order to maintain the activities of the farm village association, what are the figures that are expected to be necessary from the sales of water and farm village products? Are the figures realistic?

(7) How many associations will need to be gathered and to what extent does compact water treatment equipment has to be sold in urban areas for the local subsidiary to be able to exist as a business? Are these expectations realistic?

[Confirmed Items]

(1) Demand

- There is a market and demand for a water supply system (= safe water).
- There is a demand for local vegetables as many hotels and restaurants prefer to use safe domestically produced vegetables. Further, as there are many businesses interested in how the purchase of vegetables will contribute to improving the lives of the BOP group, there is a possibility for sales if quality, stable supplies, and appropriate pricing can be realized. In addition, upon implementing experimental cultivation of green soybeans, it has been confirmed that there are no issues with the growth thereof. However, stability in terms of quality and supply are future challenges.

(2) Water Supply System with Specifications for Local Use

- It is possible to establish a system with local resources and personnel and it is also possible to supply water of quality that is compliant with the Cambodian water standards. In addition, the cost of installation has been confirmed.
- By providing guidance, it is also possible to realize operational management and management of production and sales by local personnel including the BOP group.

(3) Estimates on Commercialization

- Estimates have been prepared for the figures that are expected to be necessary from the sales of water and farm village products in order to maintain the activities of the farm village association. (Refer to 2.3.4(7))

- Estimates have been prepared for how many associations will need to be gathered and to what extent compact water treatment equipment has to be sold for the local subsidiary to develop as a business. (Refer to 2.5.3)

(4) Challenges

- As a result of the experimental sales of water alone, "the improvement of cash income of the BOP group" and "the expansion of guidance on sanitation" will be key points towards increasing the sales of potable water. In addition, even if the price of potable water is kept significantly lower than the market price, it will be difficult to increase the amount of sales unless these factors are set in order.
- It has been confirmed that the most important challenges towards realization of the business model are the three challenges listed below.
  1) Creating a system in which the BOP group is able to purchase water
  2) Creating a system to reduce the burden of the cost of installing the water system
  3) Creating a system to increase the number of members joining as a farm village association

[Unconfirmed Items]

(1) Effectiveness and Business Feasibility of the Business Model

- A system for improving the cash income of the BOP group has not been created and the effectiveness of the business model has not been verified at the same site. For this reason, the following points have not yet been confirmed.
  - Will the BOP group that has obtained cash really purchase water? What is the scale of this which can be expected?
  - Further, about how much in terms of the cash amount can be put towards repaying the cost of installation?
  - How long of a period is expected to be required in order to recover the cost of installing the water supply system?

(2) Survey on Market for Compact Water Treatment Equipment in Urban Areas

- Can the sales of compact water treatment equipment in urban areas be expected? (Assuming that in the early stages, the equipment is exported from Japan since it will not be possible to establish a production base.)

(3) Expectations for Expansion and Development of the Farm Village Associations

- After establishing a model farming village, through hearings with local governments and government agencies, it is necessary to confirm on-site thoughts towards developing this scheme as a project.

1.3.5 Determination for Commercialization

[Conclusion]

At the current stage, we believe that further verification is required in order to make a determination on whether to proceed with commercialization.

In consideration of the abovementioned unconfirmed items and countermeasures for challenges recognized through this survey, we will continue with the verification process and eventually make a determination in regard to commercialization.

1.3.6 Future Plans towards Commercialization

- By utilizing the knowledge, personal connections, and developed and installed pilot water system, in the next step, we are planning to verify the following details by collaborating with local companies that have farms in regions near the present site.
- In the future, we are aiming to popularize the business of installing water supply systems in rural areas in units of installation of water supply and sewerage facilities at farms as well as schools and health centers, etc. in nearby regions thereof.

(Items Scheduled to be verified in the Next Step)

- Implementation of the following items will be considered during a period of approximately one year. Upon implementing the survey, implementation of the following items will be considered during a period of approximately one year. Towards implementation, considerations are being made for utilization of aid systems by international aid agencies, foundations, and donors, joint funding with a partnering company, and securing funds from public funds.

(1) Verification of creation of a system for improving the cash income of the BOP group
(2) Additional verification of possibility of sales of water to the BOP group
(3) Additional development of the pilot water supply system (development of water supply and sewerage units with specifications for local use)
(4) Survey on possibility of extended development through hearings with local governments, government agencies, and international aid agencies
(5) Survey on demand for compact water purification devices in urban areas (factories, etc.)

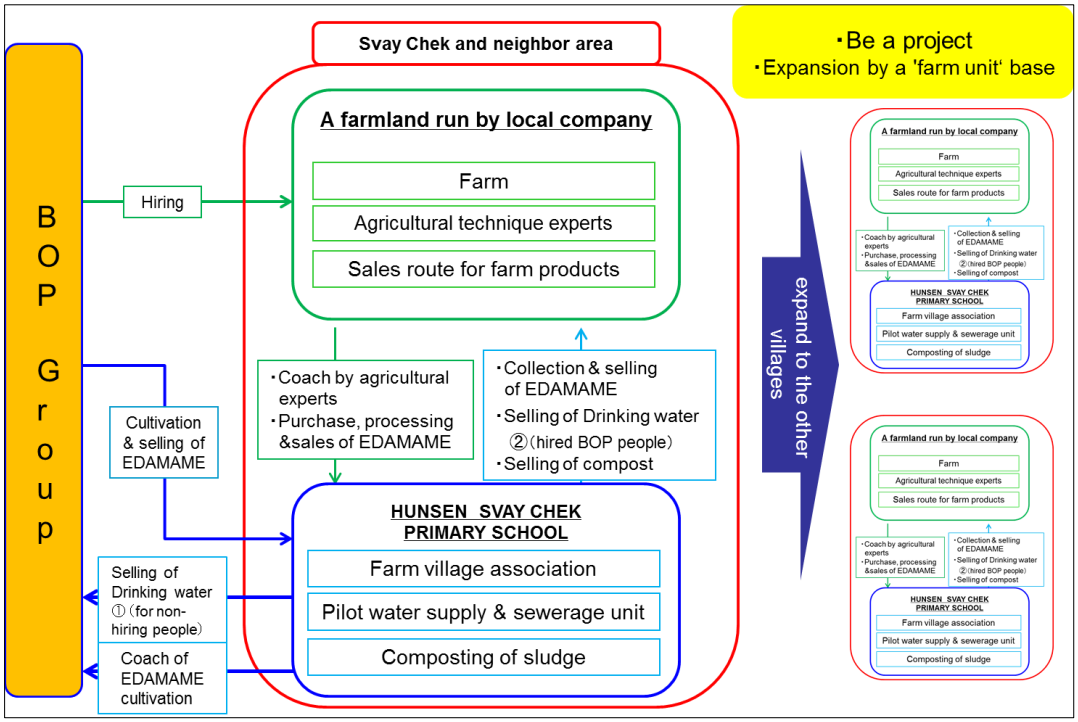

Fig. 1-2 Ideas for Verification Methods during the Next Step

Chapter 2 – Survey Results

2.1 Macroenvironmental Survey

2.1.1 Political and Economic Situations

1) Political Situation

- In consideration of reconstruction support from 1992, the Rectangular Strategy was announced in 2004 as the National Strategic Development Plan (NSDP) for the future. Focus is placed on development in the four areas of strengthening the agricultural field, reconstructing and constructing infrastructures, development of the private sector and creating employment, and structuring abilities and developing human resources.
- In September of 2014, the National Strategic Development Plan for the fiscal years of 2014-18 was announced. The current situations and issues of the four abovementioned fields were analyzed to clarify the issues for which efforts need to be prioritized. Some of the various goals listed include realizing an annual GDP growth rate of 7.0% and lowering the poverty rate of 17.9% in 2013 to 12.9% by 2018.

2) Economic Situation

- In the three years from 2011 through 2013 after the economic downturn precipitated by the Lehman Brothers bankruptcy, economic growth has been continuing at 7.1% or more.
- The main reasons for this are: (1) an increase of export by apparel manufacturers; (2) steady tourism; (3) favorable agricultural production; (4) a booming construction industry (especially with construction of housing, hotels, and factories); (5) foreign investments; (6) rapid progress of loans from commercial banks.
- The GDP per capita in 2013 increased to US$1,016. Although this rapidly decreased due to the global financial crisis after the middle of 2008, the figure recovered to 6.1% in 2010 and since then has been continuing to grow at 7.1% or more.

2.1.2 Situations involving Various Policies Legal Systems in regard to Foreign Investment in General

- Situations are based on the investment laws of the Kingdom of Cambodia and the revised laws of the investment laws of the Kingdom of Cambodia.
- As a policy regarding Foreign Direct Investment, the legal system in relation to Foreign Direct Investment is basically designed to encourage investment.
- With the exception of provisions on the ownership of land as prescribed by the investment laws, the fields in which investment is prohibited as listed in the “negative list” of “Cabinet Order No. 111 for the enforcement of the revised investment law”, and the fields in which foreigners are subject to limitations, investments are handled no differently than domestic companies.
- If a registration is filed with the Ministry of Commerce and permissions for related duties are obtained, it is possible to freely participate in investment activities. In addition, preferential treatment is provided to investors that have obtained “(investment project) Final Registration Certificates (FRC)” under the current investment laws.

2.1.3 Situations of Various Legal Systems in regard to Business Concerned

1) Legal System in regard to Water related Businesses

The current legal framework related to water businesses is as illustrated below.

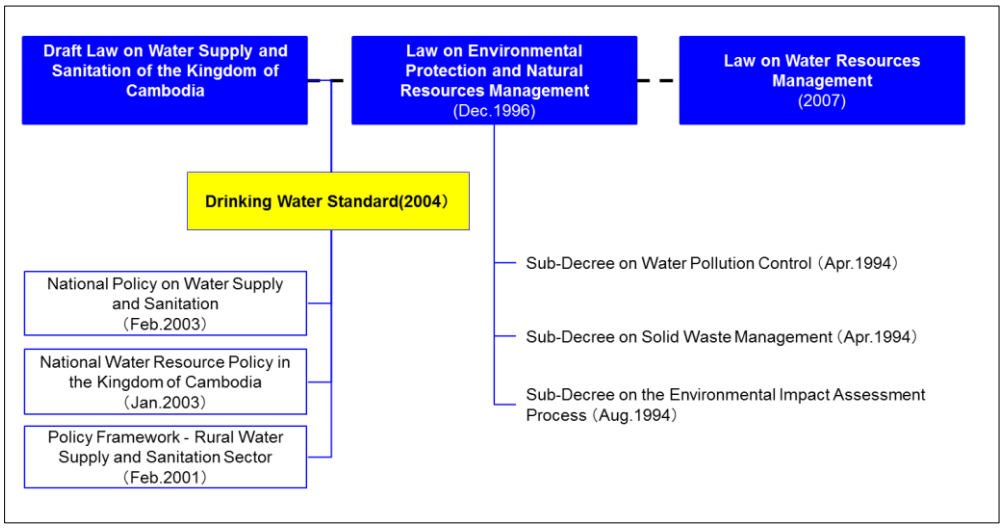

Fig. 2-1 Legal Framework regarding Management of Water Environments in the Kingdom of Cambodia
(Source: Ministry of the Environment, WEPA – Outlook of Water Environmental Management Strategies in Asia 2012)

In addition to the above, there are the following laws and ordinances (drafts) in regard to water supply businesses.

- Water Supply and Sanitation Regulation Law Draft
- Sub-Decree on River Basin Management Draft
- Sub-Decree on Water Licensing Draft

2) Legal System in regard to the Water Supply Businesses

(1) Water Supply Business Licensing System for Private Operators

- Water supply businesses can be largely classified into the water supply and sewerage business in urban areas and the water supply business in rural areas. Definitions for a water supply and sewerage business state that the operator (1) has a water purification facility, (2) supplies water through pipelines, and (3) collects charges. Such business falls under the jurisdiction of the Ministry of Industry and Handicrafts (MIH). Meanwhile, free distribution of water through a joint tap from a well in a village falls under the jurisdiction of the Ministry of Rural Development (MRD).
- Since 2010, the Ministry of Industry and Handicrafts (MIH) has been making efforts to expand the water supply network through private water supply and sewerage companies subject to the licensing system. In the revision of procedures for the issue of water supply and sewerage licenses put into effect in May of 2014, the validated period for the licenses was extended from the conventional 2 years to a maximum of 20 years. This has created an environment in which it is easier to make a long term investment.

(2) Water Quality Standards

The current water quality standards for potable water in Cambodia are as shown below. While a draft for 2011 exists as a draft for revision of the water quality standards, this has not been put into effect as of 2014.

Table 2-1 Water Quality Standards for Potable Water in the Kingdom of Cambodia (2004 version and 2011 revision draft)

Water Quality Indices	2004 Cambodian Standard Values	2011 Cambodian Standard Values in Urban area	Monitaring in 2011 standards			Remarks
			Daily	Quarterly	Annually	
pH	6.5-8.5	6.5-8.5	○			
Residual Chlorine	0.2-0.5mg/l	0.1-1.0mg/l	○			for the case that using chlorine for disinfetant
Taste and Odour	Acceptable	Acceptable	○			
E.Coli	0	0		○		
Hardness(CaCo3)	300mg/l	300mg/l		○		for the case of groundwater source
Turbidity	5NTU	5NTU	○			
Color	5TCU	5TCU	○			
Iron	0.3mg/l	0.3mg/l		○		for the case of groundwater source
Manganese	0.1mg/l	0.1mg/l			○	for the case of groundwater source
Chloride	250mg/l	250mg/l		○		
Sodium	200mg/l	250mg/l			○	case at coastal areas
Total dissolved solids(TDS) or Electric Conductivity(EC)	800mg/l	800mg/l 1600μ S/cm	○			
Lead		0.05mg/l			○	
Aluminum		0.2mg/l		○		In the case that alumium is used
Ammonia		1.5mg/l		○		
Arsenic		0.05mg/l			○	for the case of groundwater source
Barium		0.7mg/l			○	
Cadmium		0.003mg/l			○	
Chromium		0.05mg/l			○	
Copper		2mg/l			○	for the case that household plumbing uses copper pipes
Fluoride		1.5mg/l			○	for the case of groundwater source
Mercury		0.006mg/l			○	
Sulfate ion		500mg/l		○		
Zinc		3mg/l			○	
Nitrate		50mg/l			○	
Nitrite		3mg/l			○	

(Source: Cambodia Ministry of Industry and Handicrafts)

2.1.4 Market Situations

In this business model, under the supposition that it will be difficult to directly sell the water supply system to the BOP group, the model is inclusive of sales of water to the BOP group, sales of water treatment equipment to industries in urban areas, and sales of farm village products to the middle and upper class in urban areas, and assumes being related to markets in various fields.

1) Water Treatment Equipment

The following are main competitor products which were acknowledged as conflicting equivalent products.

(1) Water treatment equipment in rural areas

- Issued by an NGO or upwards of approximately US$5. An unglazed type and an installation type are available. (Only serves as a clarifier and is not capable of disinfection)

(2) Water treatment equipment (large) in urban areas

- At a large hotel, from the designing stage, water treatment equipment of an advanced country (manufactured in France, etc.) was installed.

(3) Water treatment equipment (small) in urban areas

- At small and medium hotels and restaurants, small water treatment equipment made overseas (manufactured in Taiwan, etc.) and employing the Reverse Osmosis Membrane treatment was popular. (Approximately US$300)

2) Water Supply and Sewerage Businesses

(1) Water supply and sewerage businesses (public) in urban areas

The public water supply and sewerage business operators fall under the jurisdiction of different supervisory ministries and authorities depending on the area as listed below.

1) Phnom Penh: Phnom Penh Water Supply Authority
2) Siem Reap: Siem Reap Water Supply Authority
3) Local Cities: Ministry of Industry and Handicrafts (Preah Sianuouk, Pursat, Battambang province, etc.)

(2) Water supply and sewerage businesses (private) in small and medium cities and rural areas

As of 2014, there are close to 150 private water supply and sewerage business operators and it is said that there are 200 to 300 unregistered business operators as well. The scale of each is categorized depending on the number of connected households (less than 750 to 3,000 houses or more).

3) Potable Water Sales Business

A variety of overseas and domestic potable water is being sold. Potable water mainly consumed in rural areas is sold in 20-liter containers and 500ml bottles.

(1) 20 liter containers

The price of a high-quality blue container is US$5-7 (20,000-28,000 riels) including the container), refills are US$1 (= 4,000 riels), and low-quality white containers are a flat-rate of US$1 (= 4,000 riels).

(2) 500ml bottles

Although there is a wide variety, the type most frequently seen around farming villages is sold for approximately US$1 for a dozen bottles.

Photo 2-1 Potable Water (20-liter)

Photo 2-2 Potable Water (500ml)

2.1.5 Situation of Development of Infrastructures and Related Facilities, etc.

Hearings were held with local Japanese logistics companies, the Phnom Penh Autonomous Port, and the Asian Development Bank (ADB).

In consideration of the current state of land transportation within the country, it is the understanding of local Japanese logistics companies that the establishment of a structure for logistics similar to

that of Japan will require 5 to 10 years along with the development of social infrastructures (roads, port development, electricity, storage facilities, trucks, etc.).

2.1.6 Information regarding Social and Cultural Aspects

1) Potable Water
   - In rural areas, it is not customary to pay money for and purchase water which can be accessed for free. There are even people who believe that rainwater is the safest and that water from other sources (such as well water) is water that is not safe. In addition, some have a sense of disgust for drugs and there are cases where the taste and smell of chlorine agents cannot be accepted.

2) Other
   - Due to the history of there being an informant system in rural areas during the civil war, it is said that it is difficult for organizations formed among residents to continue to exist.

2.2 Situations of Subject BOP Groups

2.2.1 Situations of Subject BOP Groups and Development Issues

1) Survey on situations of residents in model farming village candidate sites
   - Upon selecting the model farming village, status surveys (appearance surveys and resident interviews) were implemented in five framing villages centered on the Siem Reap province.
   - As a result of the status surveys, it was acknowledged that in every farming village there are many households with no cash income and there are no large differences between the living standards in each village.
   - Depending on the farming village, as there are regions that are subject to a drought in the dry season, it is difficult to secure water during this dry season and therefore it can be said that the need for water itself is extremely high.
   - While there are many households making a living off of rice farming, there are few households that are able to harvest enough to be able to sell their produce to stores. There are even some households who borrow money to buy rice when they are short on rice.

2) Results from survey on needs for sanitary water in the model farming village (Angkor Krau village)

   Total number of people interviewed: 102, Number of houses visible on map: 319, Average number of people per family: 5 or 6

   (1) Water
   - The water source of all households subject to the survey was a well. There were those with and without the smell of rusty metal and the smells differed depending on the region.
   - The people have the health and sanitation knowledge of boiling water for drinking and there are many households that use a simple water purifier provided to them from an NGO.
   - Trade of water within the village – cost price: 200-300 riels/500ml, selling price: 500 riels/500ml, 4,000 riels/20l, sold to the Phnom Pei market (closest market)
   - High numbers of people suffering from stones and joint pains may be due to the potable

water.

(2) Agriculture (Vegetables)

- Vegetables are not grown as fields often flood during the rainy season. Many households only grow enough for their own consumption and even when there are leftovers, there is only enough to be sold within the village.
- Many of the residents of the farming villages do not have “enthusiasm / fighting spirit / motivation” to overcome their situation. Popularizing the cultivation of vegetables and fruits that will not bring immediate results is one of the challenges.

(3) Work, Income, and Expenses

- The majority of people are employed for repair of ruins, security, cleaning, and construction work at construction sites. Others are employed for work of forest management, etc. and cleaning, etc. at hotels and restaurants in the city.
- Examples of work generating a cash income within the village (battery charging service: 2,500 riels/charge, liquor brewing: 2,000 riels/liter, selling ice: cost price of 16,000 riels for 2.3 m × 50 cm and a selling price of 20,000 to 22,000 riels, refilling cans of gas: 1,000 riels/can, refining rice: 800 riels/kg, etc.)

(4) Health

- Many men suffer from ureteral, kidney, and bladder stones. There are also many with joint pains.

(5) Development Issues

- There is almost no way to secure stable cash income. (Labor upon day-employment, an environment that prevents the cultivation of vegetables due to flooding during the rainy season, production volume of rice being enough for self-consumption, no special products, etc. which can be sold to tourists)
- Although wells have become popularized, the content of iron is high and the people are not satisfied with the water quality. The water is not disinfected and safe water is not available to the people.

2.3 Survey towards Verification of Realizability of Proposed Business Model

2.3.1 Preparatory Survey

1) Hearings regarding this model with related ministries

- The summary of this project was explained to the Undersecretary (at the time) of the Ministry of Industry and Handicrafts (MIH) and the Department Chief of the Department of Potable Water Supply (DPWS). While obtaining approval to move forward with the project, a variety of advice was provided. On a later date, upon request from said ministry, a study report of this project was submitted. In return, we received a letter from the Minister of said ministry expressing their support for the pilot project in the Angkor Krau village.
- The summary of this project was explained to the duty officer (local water supply department) at the Ministry of Rural Development. In a situation where there is a need for small-scale dispersion-type water supply facilities in rural areas, an oral approval for moving

forward with this project was obtained.

2) Hearings with water supply authorities

- The summary of this project was explained to the Deputy Governor of the Phnom Penh Water Supply Authority (PPWSA). While obtaining approbation, on a later date a memorandum expressing cooperation upon implementation of the pilot project was concluded. In addition to ideas on designs for development of a system with specifications for local use, a variety of advice and information such as construction and installation methods, etc. was provided.

3) Inspection of rural areas

- The Prey Veng province, Siem Reap province, Banteay Meanchey province, and Battambang province were visited for inspections of five farming villages and nine locations therein. Information was obtained on situations involving water usage in rural areas, needs for safe water, situations involving agriculture and sanitation, types of farm village products which might generate cash income, and information useful in creating a farm village association.

(1) Survey on situation of water usage in farm villages and other basic information

- A survey was conducted on situations of water sources and usage of water (types, simple water quality tests, nearby soil types, treatment status, toilets, purchasing of water, etc.)
- Rainwater, well water, and river water, etc. is stored in a water jug and used for drinking and daily life. Although situations differ depending on the village, there were some villages that had dried up wells in the dry season and villages that were flooded in the rainy season.
- The sanitary status of the water jugs and wells was poor and there were some with bugs and other dirt inside and some that even let out a bad smell. In addition, the sand filtration devices provided by an NGO were being used without regular cleaning or replacement of the filtering material and this can be thought to also have a negative effect on sanitation.

(2) Survey on basic information towards creating a farm village association, etc.

- Hearings were implemented centered on the main source of income of the BOP group, how agriculture is conducted, and sanitation.
- People earning an income from rice farming, construction work, or vegetables were found. It is assumed that this is due to such as the floods during the rainy season. According to the NGO operating the health center, there are many people suffering from tuberculosis and diarrhea occurs on a daily basis. Many of the subjects of these hearings were accustomed to boiling water. From this, it can be acknowledged that these people have sanitary knowledge to a certain degree.

2.3.2 Conducting basic surveys and preparations for creating a model farming village (Phase 1)

1) Survey for selection of the model farming village

- Although we had originally considered the Mekong River basin along National Route No. 3 as a candidate site, it became evident that the said region had a high risk of arsenic pollution. It was determined that the development of simple water treatment equipment only using

local resources would be difficult and that a treatment device prioritizing turbidity treatment would be more likely to become popular. For these reasons, the model village was selected from the northern regions with a lower risk of arsenic pollution.

- Upon selecting the farming villages to serve as model sites, the Siem Reap district, Kouk Chak commune, and Angkor Krau village were selected as villages that match a greater number of the following conditions for selection and have more elements which increase the possibility of the proposed business model functioning.

[Main Conditions for Selection of the Model Farming Villages]

- The village does not overlap with the regions of water supply business licensed operators
- There is no water supply system and there is a need for safe water
- There exists an NGO with a relationship of trust with the residents of the village
- Access to the city is decent
- There is an organization within the village which will serve as a "core" in establishing the farm village association
- There is an appropriate water source

- Upon selection, five farming villages were visited ad basic surveys (appearance surveys and interviews) were conducted. In addition, this project was explained to an NGO (Joint Support Team for Angkor Preservation and Community Development: JST) performing activities in the candidate villages and the decision was made upon confirming that it would be possible to receive cooperation.

2) Survey on needs in the model farming village

- A hearing survey was implemented at the Angkor Krau village.

The hearings were conducted on the following items in relation to a total number of 102 people and 319 houses visible on the map.

(1) Water usage situations
(2) Work (means for obtaining cash income)
(3) Agriculture (vegetable cultivation)
(4) Health

- Summary of Results from Survey

Refer to 2.2 "Situations of Subject BOP Groups".

3) Survey on demand for water at the model farming village and nearby villages

(1) Hearings regarding demand for water and treatment devices

- Assuming sales of water in the Angkor Krau village, hearing surveys in regard to the demand for water in nearby villages (within a range of 5-30 minutes by motorbike) were implemented in relation to 6 villages and a total of 161 households.
- The results are as listed below.
  - Basically, almost all households have a well and these wells do not dry up even during the dry season. There are many regions where coloration or smell due to iron is a problem.

- It can be assumed that there is a need for safe water. While figures vary between villages depending on their awareness of sanitation and degree of poverty, a certain number of people in each showed an interest in purchasing water.

(Main results from the hearings)

- 48% are satisfied with the water quality of the water currently being used *
- 75% have a family member that has suffered stomach pains or diarrhea in the past six months
- If the device is installed in the Angkor Krau village, 33% were interested in purchasing water at half of the market price (20-liter refill for 2,000 riels; US$0.5)
- 31% were interested in purchasing water even with an included cost for delivery.

4) Water quality surveys in the model villages (rainy season, dry season)

- Water quality surveys were implemented at the water source of the Hunsen Svay Chek Primary School in the Svay Chek village which is where the pilot water supply system will be installed as well as candidate locations for installation and nearby areas in the Angkor Krau village where installation was originally planned.
- For the water quality inspection items, in addition to the items of the water supply and sewerage standards of Cambodia, as toilets are not yet popular, items taking into consideration the effects of human waste and livestock on underground water and surface water as the water source were included. In addition, the differences between the dry season and the rainy season were confirmed as well.
- As a result, there were no locations within the candidate areas where arsenic concentration would be excessive. It was also indicated that the turbidity of the well water in the Angkor Krau village with treatment using the expected treatment device would be within the expected level, and that although the well water in the Svay Chek village is also decent with low turbidity, the content of iron is high which reflects the details from the hearings with residents mentioning a metal smell, taste, and color. In addition, the river water of Angkor Krau village with a higher turbidity is from the fine silt with the majority of the particle size distribution being 10 or less -20μm. This has made it evident that removal with ordinary settling alone can be expected to be difficult.

5) Surveys on agricultural crops in the model farming village and nearby cities and the demand for water treatment equipment

- The city of Siem Reap which is the city closest to the model farming village is one of the world's leading tourist cities with over two million tourists who visit annually. In this city, there are a number of hotels, both big and small, as well as restaurants.

  Hearing surveys were implemented at a total of 36 locations including major 4- and 5-star hotels with the city of Siem Reap, restaurants, major supermarkets, vegetable buyers, and owners of street stalls selling agricultural products within the market.
- Results from hearings

  1) Purchasing and product quality of agricultural products

  - It was made clear that a majority (an estimate of over 90%) of the vegetables available

are imported products from Thailand and Vietnam. It seems that a lot of the locally produced vegetables are for self-consumption or are being consumed at stores within the village. Even if some of these distributed, they are sold on an individual basis at the edge of a market or are sold at prices states by buyers who come around the farming villages. In either case, the volume of such is very limited. It is thought that this is due to not being able to realize a stable supply and a certain level of quality.

- Almost all representatives of hotels and restaurants with which hearings were conducted expressed worries in regard to the safety of agricultural chemicals used with imported crops. While chefs at hotels and restaurants are being careful to clean vegetables, they have a desire for safe domestically produced vegetables that use little or no agricultural chemicals.
- From such background, starting with the chief of the Cambodia Chef's Association, there are many that are expressing an interest in relation to how the purchase of local vegetables from this project will contribute to improving the lives of the BOP group and there is a possibility for sales if quality, stable supplies, and appropriate pricing can be realized. (22 out of a total of 26 hotels and restaurants expressed an interest in chemical-free vegetables while 21 also expressed an interest in vegetables that have been cleaned.)
- Round lettuce, asparagus, cherry tomatoes, etc. are listed as crops with a high demand due to the difficulty of obtaining these. Japanese restaurants listed items such as green soybeans and Japanese basil.
- The consumption volume in the dry season, which is the season for tourists, is twice that of the volume in the rainy season.

2) Water and water purification devices (results from surveys of 26 hotels and restaurants)

- In the city, there were many places that used both tap water and well water. (11 places that used both, 7 that only used well water)
- For drinking water, there were cases where mineral water was being purchased along with the use of water purified with a Taiwanese, etc. compact cartridge-type membrane treatment purification device (US$300) purchased from a local outlet for water treatment equipment. Water from after the treatment was used for cooking.
- In regard to the water quality of tap water and well water, many are dissatisfied with water containing rust (11 cases) and almost all places were found using water purification devices which incorporate a filter.
- As for the water treatment equipment, at large hotels, etc. it was often the case that a product from an advanced country was built in from the designing stage of the building. In cases when such was not built in, the abovementioned compact purifier devices were being used. An interest in Japanese products was expressed as being dependent on the price.
- There was no interest in one of the types of products by our company (a portable compact water purification device for use during an emergency).

2.3.3 Creating an operational system for the model farming village (Phase 2)

1) Establishing a farm village association

- Although preparations were originally being made to install the pilot water supply system in the Angkor Krau village as the model farming village, due to not being able to obtain permission for construction within the ruin protection area, we were left with no option but to install the system in a separate location outside of this area. The Svay Chek village was selected on a later date. Along with this, a farm village association was to be established as well in both villages.

(1) Details of work and association members of the management association in the Angkor Krau village:

- Main tasks: creating a structure for improving cash income centered on experimental cultivation of vegetables
- A two-man system consisting of one leader and one worker:
- The leader will be a college student selected from the youth group members of the village organized as an NGO.

(2) Details of work and association members of the management association in the Svay Chek village:

- Main tasks: producing and conducting experimental sales of potable water
- A two-man system consisting of one leader and one worker:
- As the place where the pilot water supply system is being installed is a school, a faculty member appointed by the headmaster will serve as the leader of the administrator and the other person will be employed from among nearby residents.

2) Experimental cultivation of vegetables

- As it was made clear in the results from the implementation of a survey on needs that cultivation of vegetables is barely being conducted in the Angkor Krau village, in order to verify the possibility of realizing the sales of vegetables in the city area of Siem Reap, experimental cultivation of vegetables will be implemented by the farm village association.

(1) Experimental cultivation using a solution cultivation system

- A solution cultivation system using local materials was prepared to experimentally grow baby leafs as a leafy vegetable, having a further shorter period until encashment, for which there is a demand from restaurants and different types of herbs that are said to be strong against heat. While these grew steadily up to a certain season, the plants dried up when the dry season came around and the temperature increased.
- In addition, construction work to expand the width of the river began without notice next to the lot where the pilot water supply system was scheduled to be installed. For this reason, it was not possible to install the pilot water supply system. As such made it difficult to set plans for linking this to said cultivation system, the experiment was discontinued.

(2) Experimental cultivation with open culturing

- Experimental cultivation of green soybeans was implemented within the grounds of the Angkor Krau village and the nearby Baiyon Middle School.
- Upon conducting an analysis of the soil with a simplified kit, it became evident that the nitrogen content is significantly lacking.
- Seeds produced in Cambodia were obtained and cultivated with the method commonly performed locally. While the size of the crop is slightly small at around 2/3 of that which is made in Japan, it was confirmed that there are no issues with the growth thereof.
- Upon submitting a sample to a Japanese restaurant, their response was that there is no problem with the taste and that it would be possible to make purchases if it was going to be possible to realize a stable supply. However, the majority (roughly 70 to 80%) was subject to insect damage and there are no plans yet for stable supply.
- As an idea for a method that allows each person in the BOP group to cultivate a small amount in their yards, implement measures to avoid insects, and move the crop during the rainy season and dry season, considerations are being made for whether cultivation would be possible with a cultivation method which involves placing a net over a small cultivation container.

3) Development of a pilot water supply system, survey on materials, and considerations of construction methods

(1) Development of a system with specifications for local use

- In this survey, development was considered for the following two types of systems.
  a) A system assuming a water source with high turbidity (rivers, reservoirs, swamps, shallow wells, etc.)
  b) A system assuming a water source with little turbidity and other loads (deep wells, etc.)

(2) Specifications

Based on the results from the on-site water quality surveys, the following specifications were decided.

- Flow
  a) Water intake → pretreatment basin with stones → charcoal filtration tank → sand filtration tank → disinfection → water supply
  b) Water intake → charcoal filtration tank → sand filtration tank → disinfection → water supply
- Design
  a) Processing volume: 10m^3/day (100L/person per day × 20 homes × 5 people/home)

Assumed influent quality and treated water quality:

Influent	Treated water *
- Turbidity: 10 degree (assuming direct intake of river water being roughly 20 degree)	→ 2 degree or less
- Iron: 5 mg/l	→ 0.3 mg/l or less

b) Scale decided in reference to design (a) and based on materials which can be obtained locally

Influent	Treated water *
- Turbidity: 3 degree	→ 2 degree or less
- Iron 1 mg/l	→ 0.3 mg/l or less

* The water quality of the treated water will be made to be compliant with the Cambodian water quality standards (for urban areas, 2011)

(3) Materials

Materials should be procured locally as much as possible.

(4) Construction method

With the cooperation of the Siem Reap Water Supply Authority, the system was installed by a local business operator. Construction quality and there being no collapsed foundations or leakage of piping proved a level with which there were no problems. However, some parts of the piping and electrical construction work required the skills of Japanese engineers.

4) Decision of place for installation of the pilot water supply system

- Upon obtaining permission from the commune and the Hunsen Svay Chek Primary School located in the Svay Chek village intermediated by the cooperating NGO (JST), the place for installation of the pilot water supply system was decided.

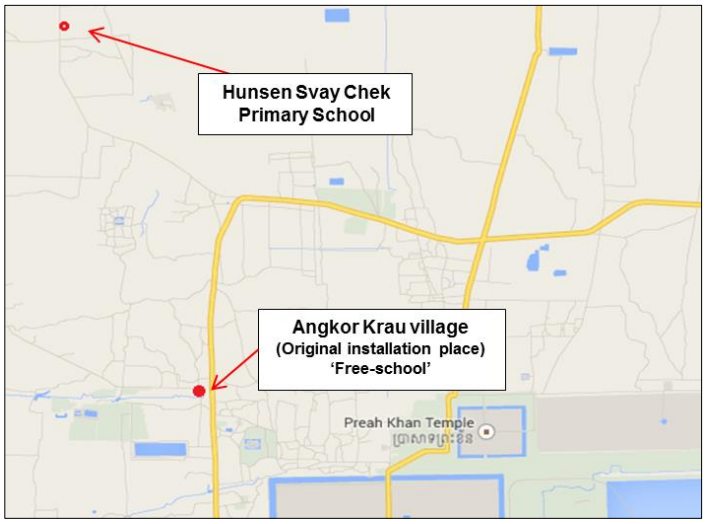

Fig. 2-2 Positions of Angkor Krau Village and Svay Chek Village

2.3.4 Implementing and verifying operational experiments (Phase 3)

1) Installation of the pilot water supply system

- This project was introduced to the Siem Reap Water Supply Authority (SRWSA). Upon receiving a great amount of cooperation with such as the arrangements of materials for construction and construction companies, the pilot water supply system was installed.
- The charcoal for the filtering material uses such which is available as fuel in markets near the village. With the help of the school, the charcoal was ground and cleaned for use.

2) Preparation of manuals for the pilot water supply system

- While instructing the farm village association on how to use, maintain, and manage the installed pilot water supply system, manuals (in the Japanese and Khmer languages) were prepared.

3) Guidance on operation by farm village association members

(1) Maintenance and management of the pilot water supply system

- Explanations were provided orally based on the manuals prepared to instruct the manufacturing of potable water as well as management of production and sales.
- For daily water quality management, the people were instructed to implement inspections and record results upon using simplified measuring instruments while referring to the water supply standards of Cambodia. In addition, regular checks of these and water quality criteria of criteria required every three months is to be inspected by the Siem Reap Water Supply Authority.
- Residual chlorine is set slightly higher at 0.4 to 0.5 mg/l and is to be managed in units of single batches (single water supply tanks holding 1500 liters). It was confirmed that the chlorine remains effective for at least two weeks in sealed bottles.

(2) Management of production and sales

A management chart was prepared for management in units of single production batches (= one water supply tank). Instructions were provided to record for each day the number of units produced, the number of units sold (with containers and without containers), and the number of units in stock.

4) Implementation of a workshop

- Nearby residents were invited to attend a workshop implemented at the school. Approximately 100 people attended the workshop. In addition to our company, affiliated personnel from the commune and the Siem Reap Water Supply Authority explained water sanitation along with this project. In addition, the product (20 liters of potable water) was provided to approximately 90 participants as a sample which served as promotion.

Photo 2-3 Residents attending the Workshop

5) Experimental sales of potable water in nearby regions

(1) In-school questionnaire (on water usage situations, etc.)

- Questionnaires were implemented with students in middles school and the 5th and 6th grades of elementary school (a total of 414 respondents).
- The majority of students have parents in the profession of rice farming. While it does seem that some are also growing vegetables, it is unknown as to whether such is being sold.
- 83% get their water from a well. Although 13% responded that they use tap water, there are

no owners of the water supply business license in nearby areas and the actual existence of a water supply system could not be confirmed. The other use rainwater (2%) and river water (1%).

- With potable water, 42% use raw water, 42% use a purifier, 16% boil the water for disinfection, and 1% use mineral water.
- 35% of the households own a purifier. 30% responded that the aspect of sanitation is an issue with drinking water. While there is a certain level of awareness for sanitation which is likely to be due to the NGO, etc. there are still many households that consume raw water. It is assumed that this difference is due to areas where the NGO is affiliated and areas where they are not.
- 64% use toilets comprising a water jug. When such is not available, they dig a hole and bury their waste in the ground.
- Common sicknesses were colds (37%) and headaches (30%). This was followed by stomach aches (9%) and diarrhea (2%) which is caused by the water. There were two cases of students with stones.

(2) Start of experimental sales of potable water

- The experimental sales of potable water in 20 liter containers was implemented in the following manner in nearby areas (approximately 800 houses in a 1 km radius) centered on the school at which the pilot water supply system was installed.
- The price was provisionally set at close to half the price of mineral water in the market (US$3.00 with container, US$0.38 for refill).
- Sales sites: schools and nearby stores (sold between 8AM to 5PM, delivery not available)
- Upon confirming that the effective period of the residual chlorine in sealed bottles is at least two weeks, water older than two weeks was to be discarded.

6) Monitoring surveys

(1) Stability of the pilot water supply system

- While there was leakage from some of the valves in the beginning, adjustments were made. Basically there have been no problems.
- The treated water quality has been stable.

(2) System for management by farm village association members

- The sequence of production such as water quality checks, etc., maintenance and management of the system, inventory management, and sales management are being performed with not problems. Further, sales management was properly managed as well.
- The desire to willingly increase the volume of sales is not too strong.

(3) Results of experimental sales

Results of hearings with villagers

- Hearings in regard to purchasing potable water were implemented in relation to 103 households within the abovementioned area.
    - 29 households equivalent to 28% of those subject to the hearings had purchased water.

- The reason for purchases by the purchasers was due to the water being “good for health” as stated by all 29 purchasers.
- Of the purchasers, 8 people responded that their health improved after their purchase.
- The transportation methods of the purchasers were (a) motorbike (14 people), (b) bicycle (13 people), and (c) foot (2 people).
- Changes in health of purchasers after the purchase (a) improved (8 people) and (b) no change (21 people)
- Other changes of purchasers (a) stopped drinking well water (7 people) and (b) stopped drinking boiled water (2 people)
- The reasons why non-purchasers did not make a purchase are as listed below.

- From the above, it can be acknowledged that in order to increase the number of purchasers, it is important to “improve cash income” and “enhance guidance of sanitation”.

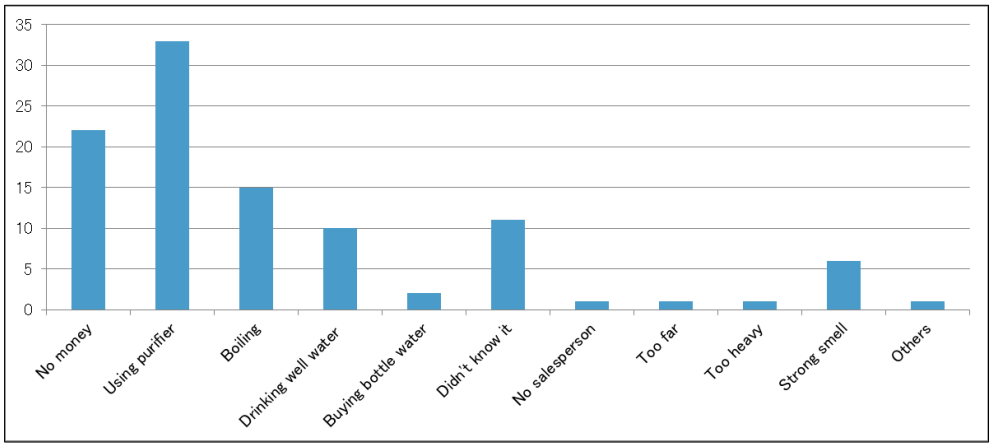

Fig. 2-3 Reasons why non-purchasers did not purchase water (multiple answers accepted)

7) Verification of account prospects in the farm village association

(1) Sales during February through April of 2015 (76 days):

- A total of 268 bottles sold (US$154). The workshop hosted on one day was the only promotional activity.
- Measures for improving the cash income of the BOP group by such as buying their vegetables, etc. had not been performed.
- With the sales of water alone, even if the unit price is significantly dropped in comparison to products in the market, it is only possible to raise enough sales to barely cover the cost of hiring two people (a total of US$100/month).
- It is necessary to include the expansion of the sales of water to nearby regions and the creation of a system for trading agricultural products.

(2) Predictions of potential demand for sales of potable water in this surveyed region

- The population in the area surrounding the Svay Chek village and the Angkor Krau village is approximately 10,000 (2,000 households)
- Assuming the monthly demand volume of a household is 10 bottles a month (a family of

5 consuming 1 bottle every 3 days), the demand in this area can be expected to be 20,000 bottles a month.

(3) Estimated balance of the farm village association

The estimated balance per farm village association is as listed below.

a) Sales of potable water

- Production volume: 30,000 liters a month (1,500 bottles) (= 1,500 liters/hour × 1 hour/day × 20 days/month)
- Sales volume: 1,125 bottles a month (75% of production volume) (= share of approximately 5% of the expected demand of the sales area)

  20% of the sales volume to be sold at the school and the other 80% to be sold through stores (half of which is expected to be delivered)
- Price (20 liters): a)-1 sold at school (1) with container (16,000 riels) (2) refill (2,500 riels)

  a)-2 sold at stores* (1) with container (14,000 riels) (2) refill (2,000 riels)

b) Sales of green soybeans

- Production volume: b)-1 Small-scale cultivation by the BOP group: 677 kg annually (twice a year, 15 farmers × 10 containers)

  b)-2 Cultivation in fields by the farm village association: 282 kg annually (twice a year, farmland of 20 m × 20 m)
- Sales volume: Each to have a yield rate of 85%.
- Price*: Purchase from the BOP group: US$2/kg, Sales to the local subsidiary: US$5/kg

Table 2-2 Income Statement Estimates of the Farm Village Association

Unit : US$

Income statement	Assumption	2016	2017	2018	2019	2020	Total
Operating income		54,912	69,464	87,872	111,158	140,614	464,019
Cost of goods sold		5,082	6,428	8,684	12,598	19,829	52,621
Gross profit		49,830	63,035	79,188	98,559	120,786	411,398
Operating expenses		22,350	24,633	27,116	29,817	32,761	136,677
Selling and administration expenses		22,350	24,633	27,116	29,817	32,761	136,677
Personnel expenses		2,400	2,688	2,976	3,264	3,552	14,880
Selling costs		19,950	21,945	24,140	26,553	29,209	121,797
Selling costs		1,350	1,485	1,634	1,797	1,977	8,242
Other contingent budgets		600	660	726	799	878	
Payments for the local subsidiary		18,000	19,800	21,780	23,958	26,354	
Leasehold and office rents							0
Depreciation expense		0	0	0	0	0	0
for land							0
for building, equipments, and reserve		0	0	0	0	0	0
Operating income (a-b)		27,480	38,402	52,072	68,742	88,025	274,722
Non-operating income		0	0	0	0	0	0
non-operating expenses		0	0	0	0	0	0
							0
							0
g Ordinary profit (c+d-e+f)		27,480	38,402	52,072	68,742	88025	274,722
h Income before income taxes		27,480	38,402	52,072	68,742	88025	274,722
i Corporation tax	25%	6,870	9,601	13,018	17,185	22006	68,680
j Net income		20,610	28,802	39,054	51,556	66019	206,041

2.4 Survey on Development of a Water Supply System with Specifications for Local Use

2.4.1 On-Site Survey for Development and Design

1) Summary

The specifications for the flow of processing and the pilot plant were decided by combining the results from the on-site water quality surveys with the results of considerations in regard to (a) the possibility of obtaining materials locally, (b) the possibility of construction with local construction technologies, and (c) the possibility of maintenance and management by local residents. Upon conducting design and construction, maintenance and management was implemented by local farm village association members. Technical information for future development of the water treatment equipment was obtained from local information gained through such.

2) Technical information items

The following technical information was obtained.

(1) On-site water quality situations (wells, rivers)

(2) Situations involving use of water by local residents

(3) Pilot plant treatment results

(4) Availability of materials and equipment (pumps, piping, structural bodies such as concrete, tanks, chemicals, etc.)

(5) Possibility of procuring electricity

(6) Situations involving management by local residents

(7) Construction quality by local business operators (cost, delivery periods, planning, etc.)

(8) Designing capabilities of local engineers

3) On-site water quality situations (rainy season / dry season)

The situations with the water quality of the raw water of wells and rivers which will serve as water sources in the model farming village and candidate sites were confirmed.

4) Situations involving use of water by local residents

Upon visiting a total of five farming villages and nine locations therein, the situations involving use of water by local residents was confirmed. As a result, it was confirmed that consideration of the two points listed below would be important in developing a system with specifications for local use.

a) As securing water volumes will be an issue especially during the dry season, it is necessary to secure a variety of water sources and consider purifying methods in accordance with these sources.

b) For the water intake method, it is necessary to use tools such as a pump that is less likely to fail.

5) Results of treatment with the pilot water supply system

The treated water quality was able to pass the current water quality standards from 2004. In regard to management, it was decided that water quality management would be conducted in accordance with the stricter water quality standards* for water supply systems in urban areas revised in 2011.

* Subject to some of the items that require measurement each day and items to be inspected every 3 months and every year.

The water source is well water and the water quality thereof is extremely good. While the turbidity of the treated water was further improved, elution from such as charcoal could be noticed with some items.

Table 2-3 Results of Treatment with the Pilot Water Supply System

Water Quality Indices	2004 Cambodian Standard Values	2011 Cambodian Standard Values in Urban area	Raw Water (Well Water)	Treated Water
pH	6.5-8.5	6.5-8.5		6.5-7.0※
Residual Chlorine	0.2-0.5mg/l	0.1-1.0mg/l	N.D.	0.30mg/l
E.Coli	0	0		
Hardness	300mg/l	300mg/l	44mg/l	19mg/l
Turbidity	5NTU	5NTU	0.3 degree	N.D.
Color	5TCU	5TCU	0.8 degree	0.5 degree
Arsenic			N.D.	N.D.
Iron	0.3mg/l	0.3mg/l	0.2mg/l	0.02mg/l
Manganese	0.1mg/l	0.1mg/l	0.033mg/l	0.064mg/l
Chloride	250mg/l	250mg/l	1.7mg/l	2.0mg/l
Sodium	200mg/l	250mg/l	2.2mg/l	1.9mg/l
Total nitrogen			0.05mg/l	0.02mg/l
Nitrate			N.D.	N.D.
Nitrite			N.D.	N.D.
Ammonium nitrogen			N.D.	N.D.
TOC			N.D.	0.4mg/l
Total dissolved solids(TDS)	800mg/l	800mg/l	76mg/l	60mg/l

※measurement figures at field

2.4.2 Specifications, Design, and Installation

1) Background

- Two types of specifications for the water supply system were configured. The first for the system installed in the Angkor Krau village and the second for the system installed in the Svay Chek village.
- In the beginning, the Angkor Krau village was selected as a candidate site for the model farming village and water quality surveys and surveys of the land were implemented.

  In consideration of results therefrom, a processing flow capable of removing turbidity and iron was established and considerations were made for the construction methods.

  However, as permission for construction was not granted in said village after this, the water supply system was installed in the "Svay Chek village".

2) Specifications of the pilot water supply system during planning for the Angkor Krau village

(1) Processing method and flow of processing

- In consideration of the results from the water quality surveys, the processing was decided to be "water intake → pretreatment basin with stones → charcoal filtration tank → sand filtration tank → disinfection → water supply".
- In rural areas where there are no waste water facilities, the rapid filtration method was not employed in consideration of the effect on the environment due to waste water containing chemicals and how maintenance and management would be difficult by local residents. In

addition, in order to protect the biological membrane of slow sand filtration, the advance chlorine injection method effective for removal of iron was not employed and instead the later chlorine injection method for disinfection only was employed.

(2) Design

- The basic specifications are as listed below.

1) Volume of treated water: 10m^3/day (100 liters/person · day × 20 households × 5 people/household) *Estimated based on results from separately conducted surveys

2) Assumed influent water quality and treated water quality

- Turbidity 10 NTU (assuming direct intake of river water being roughly 20 NTU) → 2 NTU or less
- Iron: 5 mg/l → 0.3 mg/l or less

3) Other characteristics

- The level for drinking would be the treated water after sand filtration while water for toilets and washing, etc. would be the treated water (charcoal treatment) prior to sand filtration. With such efforts to reduce the sand filtration backwash frequency and lower the relative cost by improving treatment efficiency, a method enabling easy farming village development was realized.

(3) Results

As mentioned earlier, since the Angkor Krau village is in the protection area of the Angkor ruins and permission for construction could not be obtained, it was not possible to install a pilot plant in said village.

3) Specifications of the pilot water supply system (Svay Chek village)

(1) Processing method and flow of processing

As the water quality of the well water of the water intake source is not derived from a river and is of good quality, the pretreatment basin with stones for removal of high turbidity was excluded from the flow considered for the Angkor Krau village resulting in a method employing charcoal purification and sand filtration.

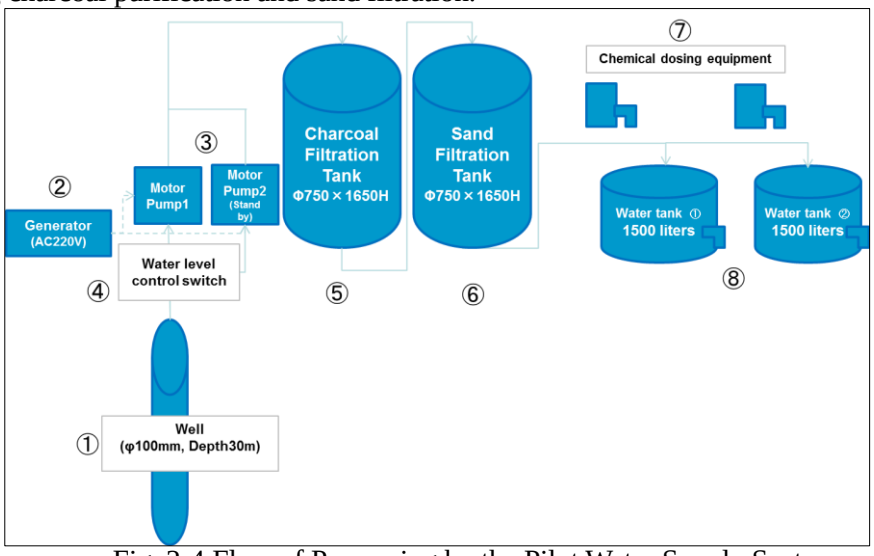

Fig. 2-4 Flow of Processing by the Pilot Water Supply System

Photo 2-4 Pilot Water Supply System

Photo 2-5 Pilot Water Supply System

(2) Design

In reference to the design for Angkor Krau village, the scale was decided based on materials that were locally available. Cylindrical water manufacturing tanks made of FRP (φ750, H = 1650) were used for the charcoal filtration tank and the sand filtration tank.

(3) Construction

While obtaining the cooperation of the Siem Reap Water Supply Authority, the system was installed by local business operators. In regard to local procurement of materials, it was confirmed that most items could be procured locally with the exception of items related to control equipment. In addition, construction quality and there being no collapsed foundations or leakage of piping proved a level with which there were no problems. However, some parts of the piping and electrical construction work required the skills of Japanese engineers.

(4) Results

1) As the water quality of the well water is comparatively decent, even with low purifying effects, it is possible to purify water to a level that is appropriate for drinking.
2) Although construction was conducted without any problems, some of the control components require on-site assembly upon indication of future design specifications. In addition, as the cleaning of charcoal required more time than expected, it is necessary to consider a more simple cleaning method.
3) As a system with an easy maintenance and management method has been employed, maintenance and management by local managers are being conducted without any problems.

4) Assumed device specifications upon future development

With this survey, the effectiveness of the method using charcoal purification and sand filtration for the aspect of water quality was confirmed. Although the scale of the device and installation costs will differ depending on the intake water source and the intake water quality, basically it is believed that the method verified in this survey is effective.

The following lists the categorized details for consideration of the device specifications.

(1) Intake water source

- Even in cases when there is a river nearby, in consideration of the fluctuation of the flow rate during the rainy season and the dry season, intake of water from a shallow well is desirable. As the bodies of water are stable with swamps and lakes, it is possible to use a thrown-in pump or directly collect water. While shallow wells differ depending on the

region, as the underground water level is comparatively high in cases where there is a water source such as a river nearby, it is possible to obtain water by only having to dig a few meters. However, in the case of the dry season or regions where there are no bodies of water nearby, it is assumed that it will be necessary to dig 20 m or more.

- The water quality of water from shallow wells differs depending on the region. In general, there is a lot of water which contains turbid qualities.

(2) Intake device and control device

- As the digging of wells by local well digging operators is mostly with a diameter of 100 mm, it is only possible to use a self-priming pump for the intake of water. Water discharge pumps which are low price and easy to handle are only available for use with manually dug wells less than 2 meters deep.
- Sensors and timers are necessary to prevent empty operation and control the time of the water intake. As the diameter of the well is small, float-type sensors practically cannot be used. Although an amplifier will be necessary with the electrode-type, as such can be configured with a simple circuit, this can be supported with self-assembly. The portion of the amplifier circuit can either be brought in upon assembly from Japan or only the component can be brought in locally to be assembled.

(3) Pretreatment basin with stones

- In cases when the water intake is from river water with high turbidity, this is necessary in order to reduce the load on the charcoal and sand filtrations in later steps.
- This will function sufficiently by simply using stones to fill either an unlined basin or an unlined basin with an impermeable liner.
- As contact precipitation can be expected downstream with the water between the stones, the effect of removal is higher than the normal precipitation method and does not require a flocculating agent. While it is ideal that the stones used are rubbles similar to that available in Japan, any kind of stones can be used as long as they are not brittle and are approximately the size of a fist. In cases when the spaces between the stones become blocked due to turbidity, the stones can be used an infinite number of times if they are taken out to be cleaned. Although this will vary depending on the particle size distribution, the retention time is between 30 minutes to 2 hours.

(4) Charcoal filtration tank

- Charcoal available locally is sufficient as the charcoal used in the system. However, it is necessary to grind this to approximately 5 cm or less and take the charcoal powder that has been ground to be sifted with a mesh, etc. and cleaned with water.
- The retention time is between 5 to 30 minutes. This is possible with both an upward current and a downward current. While removal of iron can also be expected, the effect of removing iron will become smaller once the ash content (alkaline salt, etc.) contained in the charcoal is gone.

(5) Sand filtration tank

- Filtering sand available locally is sufficient as the filtering sand used in the system. The

filtration speed will be approximately 5m/day.

- Although it is desirable that the sand has grain diameters of approximately 0.3 to 0.5 mm and an effectiveness factor of 2, sufficient purification is possible with locally available filtering sand as long as the filtering speed is configured to be slightly lower.

2.5 Establishing a Business Model

2.5.1 Processes involved in establishing a Business Model

1) Targeted business model and ideas for methods of development

- The targeted business model is as proposed with this survey. Eventually, we are aiming to develop and popularize a water supply and sewerage unit with local specifications capable of being used with various water sources including stored rainwater.
- As an idea for the development method, we are planning joint development through collaborations with a local company having farmlands. The water supply and sewerage units will be installed in the farmlands as well as schools and health centers in nearby regions and farm village associations will be established. With this "farmland + farm village association" as one unit, efforts will be made for lateral development.

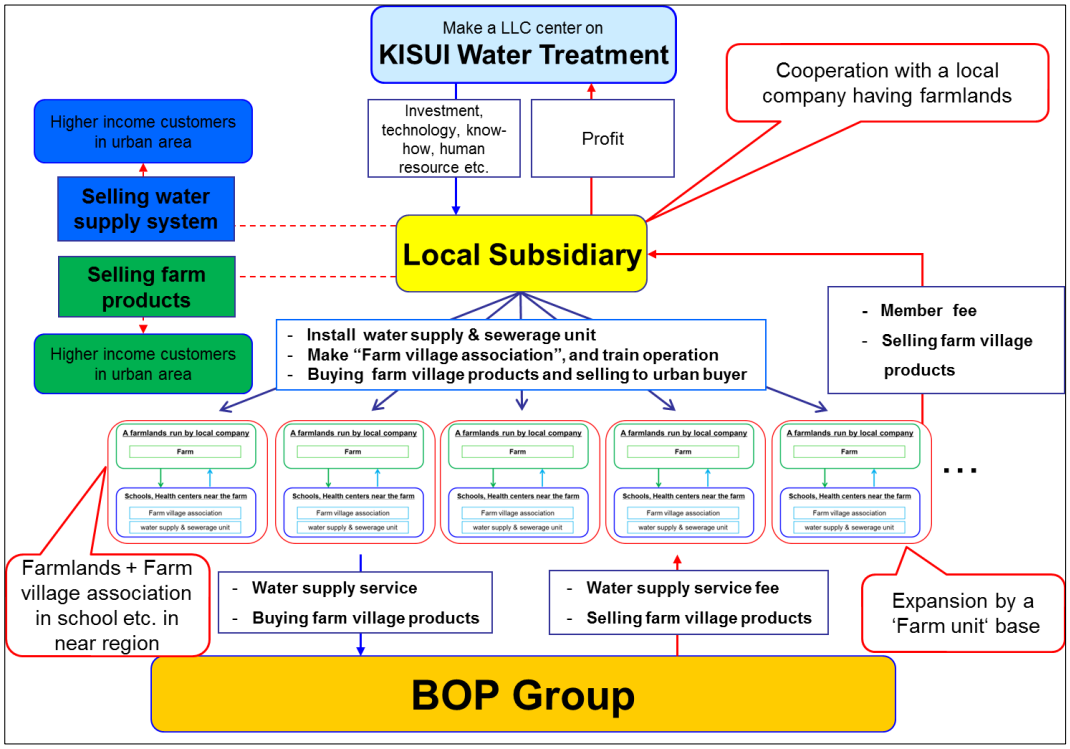

Fig. 2-5 Ideas for Development Method of Business Model

2) Processes towards commercialization

Upon going through the following processes, we will aim to establish and commercialize the business model. We are expecting additional verification of the substantiation of the business model to require 1 year, verification of popularization/substantiation and business feasibility to require 2 years, and preparation of commercialization to require approximately 1 year.

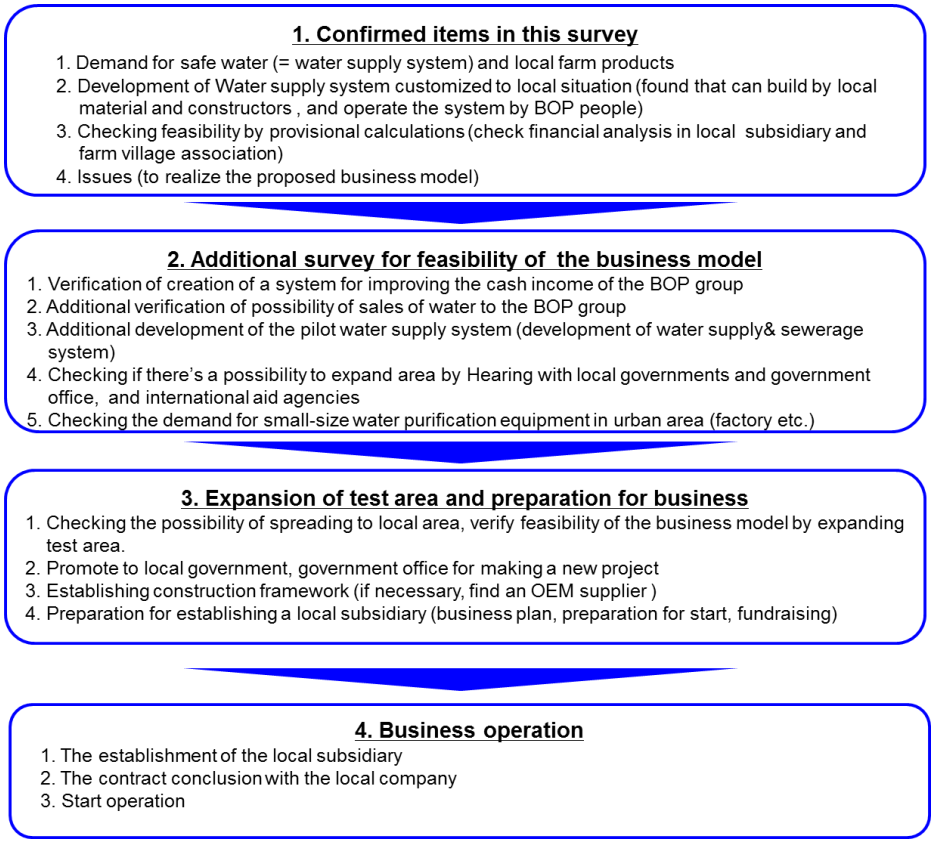

Fig. 2-6 Processes towards Commercialization

3) Implementation plans in the next step

- In consideration of the items confirmed in this survey and the challenges thereof, we are planning to implement the following details in the next step.

(1) Verification of creation of a system for improving the cash income of the BOP group

(2) Additional verification of possibility of sales of water to the BOP group

(3) Additional development of the pilot water supply system

(4) Hearings with local governments, government agencies, and international aid agencies

(5) Conducting surveys on whether there is a demand for small-size water purification equipment in urban areas (factories, etc.).

2.5.2 Local Business Partners

(1) Local companies conducting agricultural business:

- Task Details: Farm management (composting to production), instructing cultivation to the farm village association, purchasing agricultural crops from the farm village association, selling agricultural products in the market, processing of agricultural products, etc.
- Adjustment status: In the next step of this project, basic agreements have been obtained for joint activities with local companies.

(2) Manufacturing subcontractors for system production:

- Task Details: Manufacturing of a variety of water treatment equipment for urban areas.
- Adjustment status: Upon confirming the demand for water treatment equipment in urban areas and considering devices to be candidates for subcontracting the manufacturing thereof, we will look for future candidate subcontractors.

(3) Local companies having legal and labor related know-how:

- Task Details: Support with various office procedures upon establishment of local subsidiary and collaborations with local companies, etc., promotion of farm village products and water treatment equipment in the markets of urban areas.
- Adjustment status: FORVAL (Cambodia), a surveying member in this survey is capable of corresponding. An official request will be required separately upon implementation.

(4) NGO raising awareness of water sanitation:

- Task Details: Providing villages will guidance on water sanitation.
- Adjustment status: Several NGOs have been contacted. We will be consulting the possibilities of coordination with the projects of each other.

(5) Local water supply authorities:

- Task Details: Regular water quality checks of the water supply system being managed by the farm village association, introducing of business operators for the task of replacing filtering materials, introducing construction business operators to sites for new installation.
- Adjustment status: Connections with the Siem Reap Water Supply Authority and Phnom Penh Water Supply Authority have been obtained through this survey. In the Svay Chek village which is scheduled to be the site for the next step, it will be possible to obtain cooperation of the Siem Reap Water Supply Authority. An official request will be required separately upon implementation.

(6) Local authorities:

- Cooperation Request Details: Requests towards realization of the project.
- Adjustment status: Upon verification of the pilot water supply system, approval of this project has been obtained from the chief of the Svay Chek village, the council of said commune, and the ministry of education of the Siem Reap province. An official request will be required separately upon implementation.

(7) Local governments and international aid agencies, etc.:

- Cooperation Request Details: Realization of the project.
- Adjustment status: A connection with the Ministry of Industry and Handicrafts has been obtained. An official request will be required separately upon commercialization as a water supply and sewerage business.

2.5.3 Financial Analysis

If the following predictions hold true, US$15,000 for the cost of installing the water supply system can be collected in one year.

1) Assumed conditions

- The three following items are assumed as the source of income for the local subsidiary.
  (1) Affiliation fees from farm village associations (system installation fees and various support charges)
  (2) Sales of agricultural products (purchased from farm village associations and sold in markets in urban areas)
  (3) Sales of compact water purification devices in urban areas
- The monthly affiliation fee from the farm village associations has been set at US$1,500.
- The amount of the initial investment has been set at 20 million yen.
- The cost amortization period for the above is 5 years.

2) Financial statements of the local subsidiary

Table 2-4 Income Statement Estimates (Local Subsidiary)

Unit : US$

Income statement	Assumption	2016	2017	2018	2019	2020	Total
Operating income		55,524	157,146	307,940	527,316	920,237	1,968,163
Cost of goods sold		15,200	45,672	107,642	128,308	196,748	493,570
Gross profit		40,324	111,474	200,299	399,007	723,489	1,474,592
Operating expenses		74,142	95,104	161,429	229,364	325,191	885,230
Selling and administration expenses		67,742	79,664	136,945	183,832	249,605	717,788
Personnel expenses		22,200	29,568	81,840	123,216	182,928	439,752
Selling costs		45,542	50,096	55,105	60,616	66,677	278,036
Selling costs		15,542	17,096	18,805	20,686	22,754	94,883
administrative costs		30,000	33,000	36,300	39,930	43,923	183,153
							0
Leasehold and office rents							0
Depreciation expense		6,400	15,440	24,484	45,532	75,586	167,442
for land							0
for building, equipments, and reserve		6,400	15,440	24,484	45,532	75,586	167,442
Operating income (a-b)		-33,818	16,370	38,869	169,643	398,298	589,363
Non-operating income		0	0	0	0	0	0
Non-operating expenses		0	0	0	0	0	0
							0
							0
g Ordinary profit(c+d-e+f)		-33,818	16,370	38,869	169,643	398,298	589,363
h Income before income taxes		-33,818	16,370	38,869	169,643	398,298	589,363
i Corporation tax	25%	0	4,093	9,717	42,411	99,574	155,795
j Net income		-33,818	12,278	29,152	127,232	298,723	433,567

Table 2-5 Cash Flow Statement Estimates (Local Subsidiary)

Unit : US$

Cash flow statement	Assumption	2016	2017	2018	2019	2020	Total
Net Income		-33,818	12,278	29,152	127,232	298,723	433,567
±Adjustent of increase and decrease in operating cash							
+ Interest expense		0	0	0	0	0	0
Net cash provided by operating activities		-33,818	12,278	29,152	127,232	298,723	433,567
Water supply facilities		-31,386	-48,579	-47,079	-109,850	-156,929	-393,822
Registration of license		-12,000	0	0	0	0	-12,000
Vehicles		-15,000	0	0	-15,000	-15,000	-45,000
			0	0	0	0	0
Net cash used in investing activities		-58,386	-48,579	-47,079	-124,850	-171,929	-450,822
Equity	100.0%	163,934	0	0	0	0	163,934
Loan	0.0%	0	0	0	0	0	0
Repayment of principal		0	0	0	0	0	0
Interests		0	0	0	0	0	0
Net cash used in financing activities		163,934	0	0	0	0	163,934
Net increase (decrease) in cash and cash equivalents		71,731	-36,301	-17,927	2,382	126,794	146,680
Accumulated total		71,731	35,430	17,503	19,886	146,680	

Table 2-6 Balance Sheet Estimates (Local Subsidiary)

Balance sheet	2016	2017	2018	2019	2020	Unit : US$
Assets						
Cash	78,131	105,849	159,485	332,249	706,558	
Deferred assets (includes its interests)						
Fixed assets (buildings, reserves, and land)	51,986	36,546	12,062	-33,471	-109,056	
buildings and reserves	51,986	36,546	12,062	-33,471	-109,056	
land						
Total	**130,117**	**142,395**	**171,546**	**298,779**	**597,502**	**0**
Liabilities						
Loans payable	0	0	0	0	0	0
Stockholder's equity						
Capital stock	163,934	163,934	163,934	163,934	163,934	
Retained earnings	-33,818	-21,540	7,612	134,844	433,567	
Total	**130,117**	**142,395**	**171,546**	**298,779**	**597,502**	**0**

3) Sales plans of the local subsidiary

Table 2-7 Sales Plans (Local Subsidiary)

Unit: US$

Sales plan		2016	2017	2018	2019	2020
1)Sales of small water treatment Equipment in Urban area	Sales volume	1	3	8	5	10
	Sales	8,100	26,730	78,408	53,906	118,592
	Costs	7,040	23,232	68,147	46,851	103,073
	Gross profit	1,060	3,498	10,261	7,054	15,519
2)Fee from Farm village association	Association numbers	2	5	8	15	25
	Sales	36,000	99,000	174,240	359,370	658,845
	Costs					
	Gross profit	36,000	99,000	174,240	359,370	658,845
3)Sales of farm village products	New association numbers	2	3	3	7	10
	Accumlated numbers	2	5	8	15	25
	Purchased volume	1,632	4,080	6,528	12,240	20,400
	Sales	11,424	31,416	55,292	114,040	142,800
	Costs	8,160	22,440	39,494	81,457	93,676
	Gross profit	3,264	8,976	15,798	32,583	49,124
Total	Sales	55,524	157,146	307,940	527,316	920,237
	Costs	15,200	45,672	107,642	128,308	196,748
	Gross profit	40,324	111,474	200,299	399,007	723,489

4) Operation plans of the local subsidiary

Table 2-8 Operation Plans (Local Subsidiary)

1) Operating expenses (Personnel expenses)

Unit: US$

			2016	2017	2018	2019	2020
Escalation rate for personnel expenses			100%	112%	124%	136%	148%
Personnel planning	Japanese		0	0	49,104	53,856	58,608
	Cambodian		22,200	29,568	32,736	69,360	124,320
	Total		22,200	29,568	81,840	123,216	182,928
Japanese manager	Japanese	39,600	39,600	44,352	49,104	53,856	58,608
Assistant and the interpreter	Cambodian	4,800	4,800	5,376	5,952	6,528	7,104
Local manager	Cambodian	7,200	7,200	8,064	8,928	9,792	10,656
Accountant	Cambodian	6,000	6,000	6,720	7,440	8,160	8,880
Tech instructor	Cambodian	4,200	4,200	4,704	5,208	5,712	6,216
Japanese manager			0	0	1	1	1
Assistant and the interpreter			1	1	1	1	1
Local manager			1	1	1	2	3
Accountant			1	1	1	1	1
Tech instructor			1	2	2	5	10
Japanese manager			0	0	49,104	53,856	58,608
Assistant and the interpreter			4,800	5,376	5,952	13,056	21,312
Local manager			7,200	8,064	8,928	19,584	31,968
Accountant			6,000	6,720	7,440	8,160	8,880
Tech instructor			4,200	9,408	10,416	28,560	62,160

2)General and administrative expenses etc.

Unit: US$

			2016	2017	2018	2019	2020
Escalation rate			100%	110%	121%	133%	146%
Selling costs	Water selling costs	11,438	11,438	12,582	13,840	15,224	16,746
	Farm village products selling costs	4,104	4,104	4,514	4,965	5,462	6,008
			15,542	17,096	18,805	20,686	22,754
Administrative expenses	Leasehold and office rents	30,000	30,000	33000	36300	39930	43923
			30000	33000	36300	39930	43923
Depreciation expense	Water supply system	3,000	6,000	15,000	24,000	45,000	75,000
	Lisence	400	400	440	484	532.4	585.64
			6,400	15,440	24,484	45.532	75.586
Total		0	51,942	65,536	79,589	106,148	142,263

2.5.4 Plans for obtaining Permits and Approvals

- Obtaining the license for sales of potable water (upon establishment of local subsidiary)
- Obtaining the license of a water supply and sewerage business operator if water will be supplied through pipes. (To be decided)

2.5.5 Fundraising Plans

- As we have not yet reached a point where we are able to determine the possibility of commercialization with this survey, it is necessary to continue verifications. In continuing activities, considerations will be made for the options of obtaining financial aid from international aid agencies, foundations, and donors, joint funding with partnering companies, and securing funds from public funds.

2.6 Environmental and Social Considerations

2.6.1 Environmental Considerations

The installation of the pilot water system and operation experiments thereof were conducted in consideration of the following points.

- Lowering of the water level of well water
- How to dispose the filtering material of the pilot water supply system
- Storage of chlorine agents
- Noise
- Use of chemical agents for water supply systems

2.6.2 Social Considerations

The installation of the pilot water system and operation experiments thereof were conducted in consideration of the following points.

- Maintenance, management, and operation of the filtering device and bottled water

  Upon conducting verifications at the school, permissions for operation were obtained from the ministry of education of the province, the chief of the commune, and the PTA of the school, etc. In addition, approval of the region has been obtained under the condition that profits earned from the sales will be “used for operation of the school”. Management of the money from sales has been left to the headmaster and faculty members in charge of accounting at the school and is being appropriately managed to prevent embezzlement. Further, the employment of management association members after this survey is to be discussed with the local government of the region and handled by the school.
- Continuity of the project

  After the completion of the project, the Svay Check Primary School is scheduled to continue management and operation.

  A manual for how to use the water treatment equipment was prepared in the Khmer language and made accessible at all times. In addition, support has been requested to the Siem Reap Water Supply Authority with such as checking the water quality. A system is in place where they will

correspond if a problem occurs.

2.7 Effects of Development due to Implementation of This Project

2.7.1 Results from surveys regarding development issues and development effects we aim for

1) Improvement of access to safe water
   - By installing a water supply system at the school positioned in the center of the village, it has become possible for many residents to access safe water.
   - As a result of having private stores selling daily goods also sell bottled water, it has become possible for a greater number of residents to purchase water more easily.

2) Utilization in the school
   - For children and students that had been drinking well water, bottled water was placed in each classroom for them to be able to drink safe water. Due to being able to drink safe water for free at school, it is expected that the number of children experiencing stomach aches will decrease.
   - By providing children with education on sanitation as part of their school education, this will be useful in improving the sanitary situations in their homes.
   - As the wages of faculty members are so low that one must have a separate part-time job in order to make a living, there are many faculty members that turn down offers to work at schools in rural areas. By the profits earned from the water supply system managed and operated by the school being put towards operation of the school, this eliminates the need to collect money from students and children and therefore can be expected to improve the education continuance rate.

3) Increase of employment
   - By installing a water supply system in the village and selling water, it is possible to create new employment in the farming regions.

4) Measures for improving cash income
   - In the farming villages of Cambodia, there are very few households that earn cash income by selling vegetables, etc. As popularizing household farming for not only the purpose of selling such will also lead to reducing the expenses of them purchasing vegetables, this can be extremely beneficial to households with little cash income.
   - By households with little cash income cultivating vegetables for which there is a high demand from restaurants and hotels within the city of Siem Reap, it will become possible to earn cash income even in rural areas where there is no work.
   - Experimental cultivation was implemented for green soybeans which are not commonly cultivated in Cambodia. As a result, harvest was possible in all seasons except for the hottest months of April and May during the dry season and the months of October and November during the rainy season when the rain is intense. Upon establishing a cultivation method inclusive of efforts to prevent insect damage, popularization of open culturing of green soybeans will be implemented in the farming villages and the harvested green soybeans will be purchased by the management association for such to be sold in the market.

2.7.2 Scenarios towards the expression of development effects

- As a result of implementing hearings in regard to bottled water, it has become evident that 29 households equivalent to 28% of those subject to the hearings had purchased the water of this project and the reason for their purchase was due to them believing that the water was “good for their health”. Meanwhile, the main reasons for not purchasing water are “not having enough money” and “not feeling a need due to owning a purifier”.
- It was confirmed that it is necessary to improve cash income and popularize guidance on sanitation.
- In order to realize the effects of development, it is necessary to generate stable cash income of the BOP group and make efforts to improve income.
- Establishing and a cultivation method for green soybeans with which the management association is currently implementing cultivation experimentally and popularizing this to corresponding regions will lead to an improvement of cash income. In addition, if the sales of green soybeans can be realized, with monthly sales of water of 625 bottles or more, it will be possible to employ one more person for the manufacturing and sales of water.
- Continuously implementing support and hosting workshops in regard to sanitation will also be important in order to increase the number of purchasers.

2.8 Possibilities of Coordination with JICA Projects

2.8.1 Need for Coordination with JICA Projects

- In this project, in order to realize the business of selling water supply systems (and eventually water supply and sewerage units) in rural areas, the business model incorporates the production and sales of potable water, the providing of guidance on sanitation that comes along with such, and the implementation of producing and selling agricultural crops and farm village products. As this matches the key fields of the above JICA projects, making efforts for coordination with each of these JICA projects currently conducting activities in these fields is expected to create a synergy.

2.8.2 Envisioned Project Schemes

Coordination with the following JICA projects can be assumed.

(1) Coordination with ODA projects
(2) Coordination with Japan Overseas Cooperation Volunteers
(3) Coordination with grassroots technical cooperation projects

2.8.3 Specific Details of Coordinated Projects

(1) Coordination projects with ODA projects

We believe that there is a possibility for coordination with the following projects which are currently active.

a) “Project for Establishing Business Oriented Agricultural Cooperative Model” (technical cooperation)

- Coordination involving agricultural products and processed goods from the

"Business Oriented Agricultural Cooperative" created in said project being sold to selling destinations (farms, restaurants and hotels in urban areas, tourists, etc.) created in this project.

b) "Freshwater Aquaculture Improvement and Extension Project in Cambodia Phase2" (technical cooperation)

- Similar to the above, coordination involving agricultural products and processed goods from said project being sold to selling destinations created in this project.
- Alternatively, coordination involving implementation of small scale cultured production in the "farm village association" of this project.

(2) Coordination with volunteer dispatch projects

In this survey, a former Japan Overseas Cooperation Volunteer familiar with the current state of the village participated as a surveying member and implemented various surveys during activities in the village.

In the implementation of this proposed business model, a further effective approach to problems can be expected through coordination with activities such as those listed above without limiting the range of dispatch of Japan Overseas Cooperation Volunteers to the water supply business.

- Community development members providing the BOP group with guidance on cultivation of agricultural crops (agricultural field) and developing regional specialties
- Public sanitation members conducting activities to raise awareness of sanitation
- Providing guidance on management and operation of water supply systems in schools, etc.
- Conducting activities for marketing the sales of potable water to nearby villages

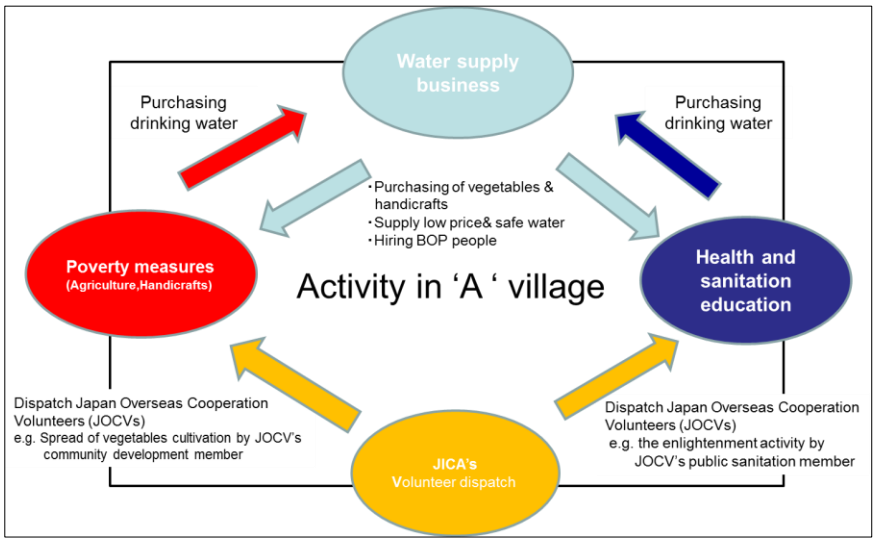

Fig. 2-7 Image of Activities for Coordination with Japan Overseas Cooperation Volunteers

(3) Coordination with grassroots technical cooperation projects

Similar to (1) Coordination projects with ODA projects listed above, coordination can be

considered in the form of agricultural products and processed goods from projects such as those listed below being sold to sales destinations of this project.

- "Cambodian agricultural products and processed goods safety improvement project"
- "Project to realize independence of community factory businesses for the purpose of realizing financial independence among women of the poorest households"
- "Structuring of a sustainable agricultural production environment in the Kampong Cham province of Cambodia"
- "Project to stimulate processing technologies of agricultural products through the reconstruction of traditional industries"

2.8.4 Effects expected from Coordination

(1) By conducting coordination at the selling destinations of the products from each of the projects listed in (3), activities become rooted in the region as profitability in the implemented project improves and sustainability increases.

(2) By Japan Overseas Cooperation Volunteers conducting education on sanitation and marketing, the number of purchasers of bottled water will increase. In addition, by having people continuously use safe water the number of people suffering from sicknesses believed to be caused by water is expected to decrease.