

Fiscal Year 2013 Water Supply Project Formation Program

Water Supply Improvement Project Study

for Yangon City and Patheingyi City

Final Report

March 2014

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Location



Source: Ministry of Health, Labor and Welfare, Study Team

1. Introduction

1.1 Outline of the project

Country: Republic of the Union of Myanmar (hereafter referred to as “Myanmar”)

Project area: Yangon city and Patheingyi city

Project name: Water Supply Improvement Project for Yangon City and Patheingyi City

Project type: Fiscal Year 2013 Water Supply Project Formation Program

Objectives of the Project:

The objectives are to improve the water supply of Yangon City and Patheingyi City and enhance water supply project planning and formation skills, water supply policy-making skills, and water supply project management skills by conducting site study from professional and technical aspects, and by studying comprehensive measures to resolve issues together with the administrators and staff in charge of water supply in Myanmar.

Background of the project:

The achievement of millennium development goals (MDGs) related to access to improved drinking water sources in Myanmar, was 82.3% in 2009-2010, which is a significant improvement from 32% in 1990 (reference year). However, the condition of urban water supply, which contributes to improving public hygiene, is inadequate in both Yangon and Mandalay. In other cities, there is a noticeable lag and there are some cities where water supply does not exist. On the other hand, economic cooperation activities have increased with the progress in the democratization of Myanmar. Presently, development studies related to water supply in Yangon City and its surrounding areas by Japan such as the “Preparatory Study for Cooperation in the Water Supply Improvement Program (JICA Master Plan 2013)” are in progress, and developments in the provision of water supply are anticipated in Myanmar, which presently lags other countries.

Based on the background mentioned above, a Study Team consisting of experts from two companies and from Yokohama City that formed the consortium this time, was dispatched by the Ministry of Health, Labor and Welfare in Feb 2013 to Myanmar. The Study Team implemented the study for the formation of water supply project plans on three cities of Yangon, Mawlamyine and Patheingyi, called the “Myanmar Water Supply Management Improvement Project for Three Cities (Ministry of Health, Labor and Welfare FY 2012 Study).”

As part of this project, it was proposed to formulate water supply project plans for Yangon City and Patheingyi City (Mawlamyine City not included where provision of water supply through sectoral program loans from Japan is anticipated), bearing in mind the use of mobile water purifiers proposed in this Study.

Project description:

Yangon City

JICA Master Plan 2013 currently in progress, envisages development of water supply system (see Fig. 2.1) to the Yangon metropolitan area in 2040 with six townships in the vicinity added to the present service area (33 townships). The plan also considers provision of water supply at the intermediate point (2025) in the foreseeable future. However, it is estimated that a considerably long time will be required for water supply to reach the ends of the area even if the provision of water supply progresses according to plan, and the resolution of unserved isolated communities in the vicinity or the delay in provision of water supply are especially worrisome.

In this study, candidate areas for the project, where safe drinking water has not been adequately ensured and improvements from hygiene aspects are desirable, were selected through consultations with YCDC, and the actual status of drinking water was grasped through site surveys. Effectiveness of ensuring safe drinking water by mobile water purifier was also confirmed, and instruction on formulating of the project plan which aims to make interim water supply by using such equipment until the development of full-fledged water supply system are completed was conducted.

Patheingyi City

This is Myanmar's sixth biggest city. Although it is the biggest city in the Ayeyarawady region with urban development anticipated to go hand-in-hand with economic development, water supply has still not been provided in Patheingyi City.

Taking into account the 2012 study report of the Ministry of Health, Labor and Welfare, the O&M cost for the mobile water purifier was examined, and the selling price of the drinking water was also estimated preliminarily, and willingness of residents to pay for the drinking water was confirmed. Based on such studies, the business model that the new water supply board supplies the drinking water for a price while full-fledged water supply system is under construction was proposed, furthermore instruction on formulating of the project plan was conducted in this study.

Based on the results of the report above, the O&M cost of mobile water purifiers in Patheingyi City will be closely studied, preliminary estimates made on the selling price of drinking water, and the willingness to pay of the residents will be confirmed. The business model of the Water Supply Board that will sell the drinking water will be studied while making provision for a modern water supply system (see Fig. 3.4), and plans formulated for the proposed project.

1.2 Project stages and methods

Project stages

General Affairs :	Japan→Yangon→Pathein→ Naypyitaw Yangon→Japan
Experts:	Japan→Yangon→Pathein→ Naypyitaw Yangon→Japan
Support to General Affairs:	Japan→ Pathein→Naypyitaw Yangon→Japan
Yangon Team:	Japan Yangon Japan
Pathein Team:	Japan Pathein Japan

Organizations for discussion (For list of interviewers, see Document 1)

Yangon City Development Committee/Pathein City Development Committee/ Ministry of Planning and Economic Development, Myanmar / Ministry of Foreign Affairs, Myanmar.

Project implementation method

Yangon City

Discussion before the study (selection of candidate area for the project), data collection and site survey, general discussion on the results of studies (forming a consensus on problem solving policy, introduction of mobile water purifier by presentation)

Pathein City

Discussion before the study (selection of candidate service area), data collection and site survey, general discussion on the results of studies (forming a consensus on problem solving policy, introduction of mobile water purifier by presentation)

Ministry of Planning and Economic Development & Ministry of Foreign Affairs, Myanmar
Overview and summary of the Water Supply Improvement Project for Yangon City and Pathein City based on the results of the study and confirming the intention of Myanmar

1.3 Composition of the Study Team

Name	Responsible for	Belonging to
Shiro JIMBO	Project in-charge / General / Site Supervision	TEC
Makoto KANEKO	Yangon City / Water supply planning	TEC
Wataru SAIKA	Yangon City / Mobile Water Purifier System / Water Supply Project Planning	TEC
Kazushi HASHIMOTO	Patheingyi City / Deputy Team Leader / Water Supply Project Management	Yachiyo Engg.
Mitsuhiro OMORI	Patheingyi City / Water Supply System Planning	Yachiyo Engg.
Yoshiharu WADA	Expert / WaterSupply System Operations and Management	Yokohama Water Co. Ltd.
Emi KATO	Mobile water purifier implementation plan	Metawater Co., Ltd.
Yu ONODERA	Work coordination support/water purifier implementation plan	Metawater Co., Ltd.
Osamu NAKAGOMI	Advisor (will not participate in site studies)	Metawater Co., Ltd.

2. Understanding the status of the project

2.1 Water supply situation and problems in Myanmar

2.1.1 Status of the water supply sector (national level)

According to an announcement by the Government (November 2006) on the status of achievement of development target related to access to improved drinking water sources in Myanmar, the percentage of access has increased from 32% (urban area 38%, rural area 30%) in 1990 (base year) to 79% in 2003. According to a similar announcement by the Ministry of Health (February 2002), the achievement level has improved to 82.3% (urban area 93.2%, rural area 77.6%) in 2009-2010. However, since the chlorine injection in the Yangon water supply system is inadequate, doubts remain on whether the water can be treated as safe drinking water.

2.1.2 Problems in water supply (national level)

The contribution of municipal water supply to improving public hygiene is inadequate in the major cities of Yangon and Mandalay. In other provincial cities, there is a noticeable lag and there are some cities where water supply does not exist. Not only is the provision of facilities delayed, but also the provision of various related systems and human resource development is delayed. Henceforth, overall development is necessary, such as coordination with the health sector, provision of systems, improved management of the Water Supply Board, and human resource development.

For support to Myanmar in the provision of water supply systems aiming for steady and safe water supply, Japan had dispatched experts for the long term and the short term to the waterworks utility prior to 2004 for the development study of Yangon City and Mandalay City in 2000, before the movement toward democratization in Myanmar. Presently, the “Preparatory Study for Cooperation in the Water Supply Improvement Program (JICA Master Plan 2013),” which is the development study for provision of water supply to Yangon City and its surroundings, is being implemented. Grant aid cooperation (urgent rehabilitation plan for water supply facilities) and dispatch of advisors for supply of water for domestic use are underway, and these are anticipated to contribute to steady and safe water supply operations.

2.1.3 Problems related to hygiene and waterborne infectious disease (national level)

The status of diffusion of sanitation facilities in 2010 according to WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation is 76% for the whole country (urban 83%, rural 73%).

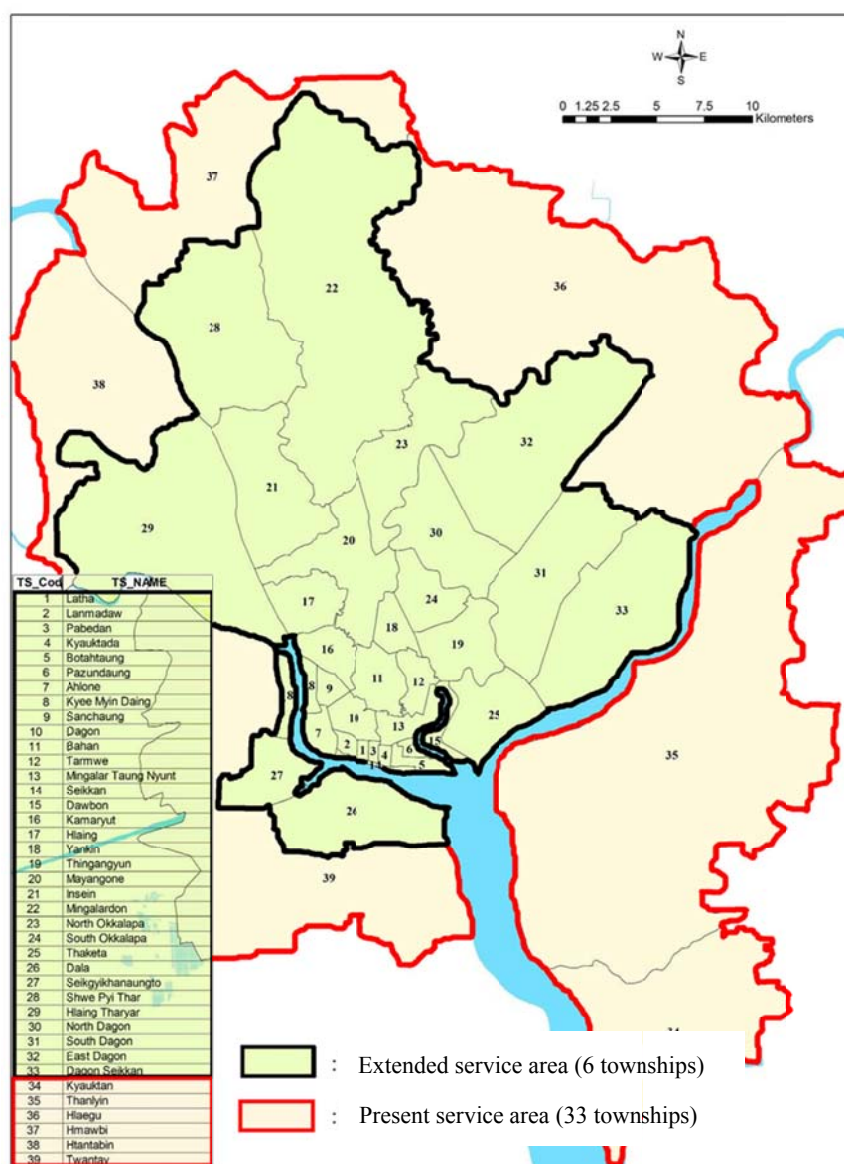
In relation to waterborne infectious diseases, the accessibility to improved drinking water sources in 2010 in Myanmar was 83% (urban 93%, rural 78%). However, the served population

ratio in urban area is just 19%, and water is not entirely safe for drinking; there is a risk of waterborne infectious disease. Considering that disinfection is also inadequate in the water supply of Yangon City, water quality control in other areas is presumed to be inadequate, and risk is likely to be much higher.

2.1.4 Study area (Yangon)

1) Status of water supply and problems in the supply of drinking water

The Yangon water supply service area consists of 39 townships. Fig. 2.1 shows the positions of these townships.



Source: Ministry of Health, Labor and Welfare, Study Team

Fig. 2.1 Map of Yangon water supply service areas in the future

The water supply in the study area may be broadly divided into the YCDC water supply and others. Water supply sources by township is shown in Table 2.1 below.

Table 2.1 Water supply sources by Yangon township (as in 2011)

Township	YCDC water supply (%)	Public wells and taps (%)	Outline of other water sources
Presently served area – 33 townships	38		
Townships with water supply <15% within YCDC			
25 Thaketa	14	1	Private wells 44%, water vendors 35%, others
26 Dala	5	0	Stormwater/streams/lakes 71%, water vendors 20%, others
27 Seikgyikhanaungto	0	0	Stormwater/streams/lakes 71%, water vendors 22%, others
28 Shwe Pyi Thar	7	3	Private wells 75%, neighboring wells 12%, others
29 Hlaing Tharyar	2	1	Private wells 69%, neighboring wells 23%, others
33 Dagon Seikkan	11	4	Private wells 42%, water vendors 25%, others
Outside YCDC(6 townships near Yangon district – JICA Master Plan 2013 extended water supply areas			
34 Kyaktan	13	11	Neighboring wells 29%, stormwater/streams/ lakes 29%, others
35 Thanlyin	0	6	Private wells 29%, neighboring wells 22%, stormwater/streams/ lakes 23%, others
36 Hlegu	1	2	Private wells 43%, stormwater/streams/ lakes 44%, others
37 Hmawbi	1	6	Private wells 61%, neighboring wells 30%, others
38 Htantabin	0	0	Private wells 38%, Neighboring wells 17%, stormwater/streams/ lakes 39%, others
39 Twantay	0	0	Stormwater/streams/lakes 93%, others

Source: Ministry of Health, Labor and Welfare, Study Team

Townships with YCDC water supply of 15% or less are 6 out of the 33 townships presently served by YCDC, and 6 townships to be extended according to the JICA Master Plan 2013.

➤ YCDC water supply

Water is being supplied to service areas consisting of 33 townships located in the southern part of the Yangon Region. The summary of the service areas tabulated according to the JICA Master Plan 2013 is: population of about 5,140,000; served population of about 1,930,000, coverage of about 38%, average water supply rate of 610,000 m³/d, and NRW(non revenue water) of about 50%.

- Low served population ratio

- Insufficient capacity of facility
- Restriction of water supply as a consequence (average 9 hours)
- Lower water pressure and high leakage ratio
- No disinfection of water in most of the service areas (only Yegu pumping station has the facility for chlorine injection)

Chronic issues faced are.

➤ Water supply other than YCDC

Other sources of water supply include private wells, rain water storage, small streams/lakes, tap water and well water from neighboring houses, bottled water, water vendors, public wells and public water hydrants. Small-scale public water supply facilities exist in Thanlyin and Kyauktan townships and Thilawa SEZ located in the southern part on the left coast of the Bago River outside Yangon City.

➤ Yangon water supply provision plan

New water source development and future metropolitan water supply concept inclusive of the extended water supply service area (39 townships) consisting of 33 townships served presently and 6 additional townships in the vicinity were in the study stage for adopting measures against the rising water demand accompanying the increase in population and rapid economic growth in addition to the chronic water shortage in Yangon City. It is presumably considered in the context of said concept through discussions and coordination with Yangon City in the ongoing study "Preparatory Study of the Yangon City Water Supply Improvement Program" started in August 2012.

As a solution to the present issues enveloping the water supply, the JICA Master Plan 2013 envisages provision of water supply (see Fig. 2.1) in the target year 2040 to the Yangon metropolitan area consisting of the presently served area of the city (33 townships) and 6 townships in its vicinity. The plan also shows provision of water supply at the intermediate point (2025) in the foreseeable future. However, a considerably long time will be required for the water supply to reach the ends of the areas even if the provision of water supply progresses in line with the JICA Master Plan 2013. Resolving the problems of unserved isolated communities in the vicinity and the delay in provision of water supply are especially causes for concern.

2) Status of sanitation and issues related to waterborne infectious disease

➤ Status of sanitation

Table 2.2 shows the status of sewage treatment in YCDC. The sewered population is only 7.3% of the entire population, and more than 90% of the population depends on individual treatment. Persons with no toilet, although small (0.3%) , do exist.

Table 2.2 Status of sewage treatment in Yangon City (2002)

Treatment facility	Percentage of population (%)
Sewerage system	7.3
Septic tank	18.4
Pour-flush toilet	28.0
Fly-prevention toilet	18.0
Unsanitary toilet	28.0
No toilet	0.3

Source: YCDC

The Yangon City sewerage system has been continuously used since the last 120 years through improvements after it was constructed in 1890 when under British rule. The drainage areas of the sewerage system are the eight townships in the commercial area at the center of the city. This drainage is treated by the sewage treatment plant completed in 2005, with the treated water being discharged into the Yangon River. Urbanization due to rapid economic growth and increase in population went hand in hand with the ageing of sewerage facilities, and wastewater treatment has become a pressing issue. Similar to water supply, a master plan for wastewater treatment is being prepared presently.

➤ Issues related to waterborne infectious disease

Table 2.3 shows the number of patients and fatality suffering from waterborne diseases and the number of mortality in the Yangon district.

62% of the residents excluding those (38%) receiving YCDC water supply have been using water that has not been subjected to appropriate water quality controls as drinking water, and these residents are exposed to the risk of waterborne infectious disease.

Disinfection by chlorine in the YCDC water supply is inadequate, and more appropriate disinfection by chlorine is anticipated in the future.

Table 2.3 Number of patients suffering from waterborne diseases and mortality rate in the Yangon district

Sickness	2007		2008		2009		2010		2011	
	No. of patients	No. of deaths	No. of patients	No. of deaths	No. of patients	No. of deaths	No. of patients	No. of deaths	No. of patients	No. of deaths
Cholera	4	0	49	0	191	7	22	1	37	0
Diarrhea	17,344	7	17,462	9	13,166	10	11,851	2	10,969	4
Dysentery	8,507	0	9,489	0	6,135	0	6,361	0	4,436	0
Food poisoning	244	7	259	3	435	7	255	0	395	0
Typhoid & para typhoid	103	1	71	1	55	0	98	0	47	0
Viral hepatitis	188	6	251	1	14	4	271	3	205	2

Source : Yangon Regional Health Department, Ministry of Health

2.1.5 Study area (Pathein)

1) Status of water supply and problems in the supply of drinking water

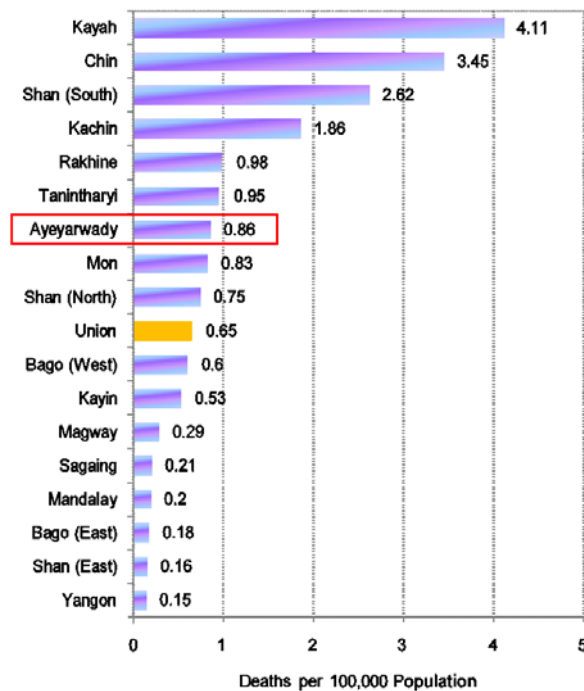
Pathein City does not have a modern water supply system. Two bottled water manufacturing plants using RO membrane technology and 1000 or more water vendors (estimated) have the role of supplying drinking water in Pathein City. Water vendors take comparatively good quality water from wells (mainly shallow wells) in temples, etc., fill it in plastic tanks and sell it from house to house. Many of the ordinary residents have wells (shallow wells) in their houses, but the quality of water in most of these wells is poor and unfit for drinking. Consequently, ordinary residents buy bottled water for drinking, but some of the residents, especially poor people either drink well water and water in rainwater storage ponds as-is, or after boiling it.

2) Status of sanitation and issues related to waterborne infectious disease

As mentioned above, Pathein City does not have a modern water supply system, and a major part of the population does not have access to safe drinking water such as bottled water.

Fig. 2.2 shows the moratality due to diarrhoea by state and division in Myanmar, as an example. The mortaility rate due to diarrhea in the Ayeyarawady Region including Pathein City is 0.86 per 100,000 persons, which is more than five times the corresponding value of 0.15 in the Yangon Region.

Mortality of Diarrhoea by State and Division 2008



Source: HMIS, Department of Health Planning, Ministry of Health

Fig. 2.2 Mortality due to diarrhea in Myanmar by states and divisions

2.2 Related plans

2.2.1 Overview of development plan

1) Yangon

The Myanmar Government held discussions with JICA on formulating comprehensive development plans for the Yangon metropolitan area including development of basic infrastructure such as water and sewerage systems, power, roads and so on, after the rapid developments in the political status of Myanmar. After these discussions, the minutes of the meeting related to “Yangon City Development Program” was signed on 1 May 2012, and agreement was reached on cooperation for city development earmarked in the program. Studies relevant to these are described below.

- Yangon Metropolitan Area Development Program Formation Preparatory Study (JICA): “Yangon Metropolitan Area Study”
- Basic Data Collection Related to Inventory of Water Resources in the Tilawa Special Economic Zone and Surrounding Areas (JICA): “Thilawa Inventory of Water Resources”

- Preparatory Study on Cooperation in Water Supply and Sewerage System Improvement Program for Yangon City in Myanmar (JICA): “JICA Master Plan 2013)

These are ranked as the higher ranked plans related to the 2012 Water Supply Project Formation Program.

Additionally, other studies to be implemented before include the following:

- Basic Study on the Improvement of Water Supply and Sewerage Systems in Yangon City in Myanmar (Ministry of Economy, Trade and Industry): “METI Study”

2) Patheingyi City

A project plan on the Patheingyi City water supply exists, prepared by the Ayeyarawady regional government with technical assistance from the Central Government (Ministry of Border Affairs at that time).

2.2.2 Urgency and priority of Myanmar in relation to the relevant proposals

Diarrhea (5% in 2010) ranks as the fourth in the list of ten important causes of mortality due to diseases in Myanmar. The health index traced to the water system in Yangon City and Patheingyi City (number per 100,000) is as shown in Table 2.4 Coordination with the health sector to ensure safe drinking water, and so on, is vitally important to improve this situation.

Table 2.4 Health index related to Yangon City and Patheingyi City

	Mortality rate due to diarrhea*1	Status of waterborne infectious disease*2		
	2008		2010	2011
Yangon District	0.15 per.	Yangon City	313 per.	266 per.
Ayeyarawady Dist.	0.86 per.	Patheingyi City	552 per.	510 per.

Source: * 1: Data acquired from WHO Myanmar Office

* 2: HMIS, Department of Health Planning, Ministry of Health

1) Yangon

Yangon has continued to develop as a major economic center even after relocation of the capital to Naypyidaw in 2006. The provision of infrastructure to support Yangon has become an urgent task presently. The provision of water supply system to support domestic and urban activities is becoming a reality with the formulation of the JICA Master Plan 2013. However, a considerable amount of time will be required for the benefits of this provision to reach the entire city. The provision of water supply to the surrounding communities is most likely to be in the last stage.

The number of persons afflicted with waterborne infectious disease shown in Table 2.4 indicates

a decreasing trend suggesting that the decrease has occurred with the provision and diffusion of water supply systems. The difference in the status of a large city such as Yangon, where water supply has diffused, and a core provincial city such as Patheingyi City where water supply is yet to be provided, is indicated by the health index value. The candidate project area in the present study is different from the centre of Yangon City; its status similar to that of Patheingyi City in which water supply is yet to be provided. Since residents drink rain water as-is, there is a high risk from the viewpoint of health and hygiene. The proposed project aims to achieve the Millennium Development Goals and to make improvements from health and hygiene aspects. Moreover, the needs are very important and urgent; besides, this is a matter anticipated to lead to the realization of water supply in village communities at an early stage.

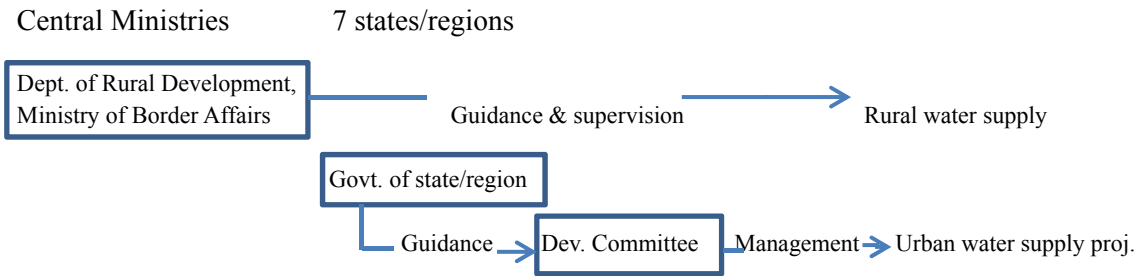
2) Patheingyi City

Patheingyi City is the sixth largest city in Myanmar, and it has prospered as a port city. It is also a physical distribution base on the western delta, and is expected to develop as a major city with the economic development of Myanmar in the future. The provision of water supply facilities, an important infrastructure component, is extremely vital to the development of the city and access to safe drinking water; therefore, its immediate materialization is essential.

2.3 Responsible authority and implementing organization

2.3.1 Administration of water supply in Myanmar

After reorganization of the ministries in September 2012 as shown in Fig. 2.3, no functions of centralized guidance and monitoring of urban water supply existed in the administration of water supply in the whole of Myanmar. The authority for doing so has been entrusted to the government of each state/ region.

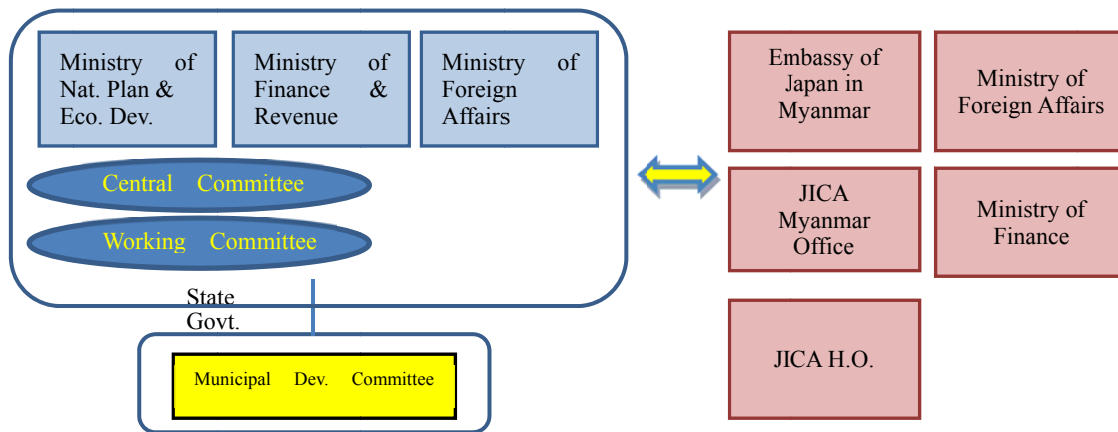


Source: Ministry of Health, Labour and Welfare, Study Team

Fig. 2.3 Administration of water supply in Myanmar

Fig. 2.4 shows the flow of ODA requests to Japan related to urban water supply. Project requests were made by the Development Committee managing urban water supply to the Central Government through state/regional government. Meeting and coordination with organizations of

the Japanese government will proceed after the committee meetings of the relevant ministry. However, since there is no ministry or agency for administering urban water supply in the central government, and especially since an exclusive department for water supply does not exist in the regional towns, the realization of the project is largely influenced by how vigorously the concerned regional town and regional district urges the Central Ministry to make ODA requests.



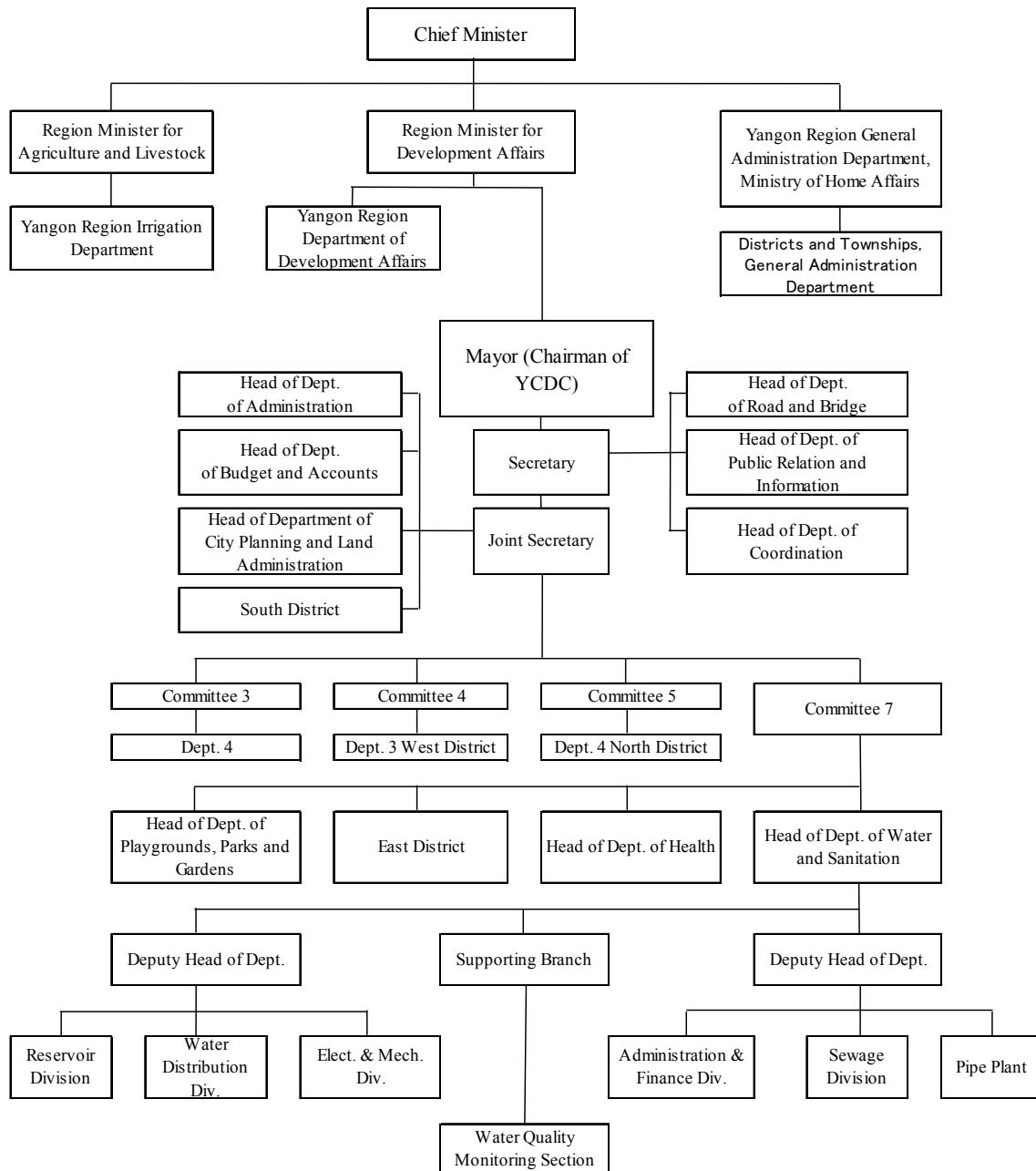
Source: Ministry of Health, Labour and Welfare, Study Team

Fig. 2.4 Flow of ODA requests to Japan related to urban water supply

2.3.2 Project implementing organizations and projects

1) Yangon Region and Yangon City

The Yangon City Development Committee (YCDC) is the implementing organization for the relevant project. YCDC falls under the jurisdiction of the Minister of State for Regional Development, as shown in the overall organization chart of YCDC and in the list of departments of the state government in Fig. 2.5.



Source: YCDC

Fig. 2.5 Overall Organization Chart of YCDC and related departments in Yangon Region Government

➤ Yangon City Development Committee (YCDC)

YCDC has the the right to implement projects independently using funds on hand according to the Yangon City Urban Development Law. However, approval request of project is necessary presently, and so also consideration should be given to activities included in the framework of the national budget. Moreover, the environment for adequately exercising this right is not yet ready.

This organization has a committee consisting of members under the mayor (also serves as State Minister of Development) including the Secretary, Joint Secretary and four executive directors (of committees 3, 4, 5, and 7). Various policies are discussed in this committee. One of the roles of YCDC is water supply, sewerage and sanitation, which falls under the jurisdiction of the Department of Engineering (Water and Sanitation).

➤ Department of Engineering (Water and Sanitation)

As shown in Fig. 2.5, the Department of Engineering (Water and Sanitation) consists of six divisions and has 2,196 employees (as in June 2012). It manages and operates water supply and sewerage systems. Requests for water quality inspection are made to the Department of Health under Committee 7. The Water Quality Monitoring Section of the Supporting Branch and the Dept. of Water and Sanitation have the responsibility of monitoring the quality and managing the results.

After realization of the project, the Dept. of Water and Sanitation will manage the operation and maintenance work.

2) Patheingyi City

Presently, no organization responsible exclusively to water supply facilities exists in the Patheingyi Township Development Committee.

To provide water supply system in Patheingyi City henceforth, an organization responsible exclusively for water supply must be set up at an early stage. The newly established Water Supply Board should preferably introduce management systems equivalent to those at international levels by contract agreements with international water operators for managing the water supply system.

2.4 Japanese cooperation in the past

2.4.1 Financial cooperation in the past

Financial cooperation with Myanmar began with the "Japan-Burma Peace Treaty and Compensation Economic Cooperation Agreement" in 1954. Financial cooperation by JICA ODA loan started with economic cooperation in 1968, while grant aid was offered from 1975

onward. However, no new JICA ODA loans were granted after 1987. After the democratization movement in Myanmar recently, JICA ODA loans were resumed from January 2013 based on the new Myanmar economic cooperation guidelines.

ODA in the water supply sector in the past was mostly grass-roots grant aid and NGO aid. Aid for water supply provision in urban areas was as below; substantial assistance began from 2012 onward.

Loan assistance

Fiscal 2013 Poverty Reduction Regional Development Plan (Phase 1)

Grant aid cooperation

Fiscal 2013 Yangon City Urgent Rehabilitation Plan for Water Supply Facilities

Development studies

FY 2000 The Study on Improvement of Water Supply System in Yangon City

FY 2000 The Study on Central Drainage Water Supply Plan for Mandalay City

FY 2012 Basic Study on Improvement of Water Supply and Sewerage Systems in Yangon City (Ministry of Economy, Trade and Industry)

FY 2013 Preparatory Study on Cooperative Program for Improvement of Water Supply and Sewerage Systems in Yangon City

Welfare and Medical Cooperation Projects in South-east Asian Countries

FY 1997 Study on the Status of Provision of Water Supply in the Union of Myanmar

2.4.2 Technical cooperation in the past

The track record of cooperation by Japan's water supply corporations is as given below. Note that records of cooperation are few in number, and technical cooperation related to water supply has just started.

FY 2002 Long-term dispatch of individual experts (2 years)

FY 2004 Short-term dispatch of individual experts (4 months)

FY 2012 Domestic water supply advisor (underway)

2.5 Cooperation by third country/international organization related to the project

1) Yangon City

At the time of site study, ADB acquired data on implementation of feasibility study of grant aid

project (water supply, toilets, wastewater, etc.) for areas with no water supply network of the Dala township from the JICA Myanmar Office. However, relevant data from YCDC has not been acquired; therefore, measures need to be adopted to do so while carefully watching trends henceforth.

2) Pathein City

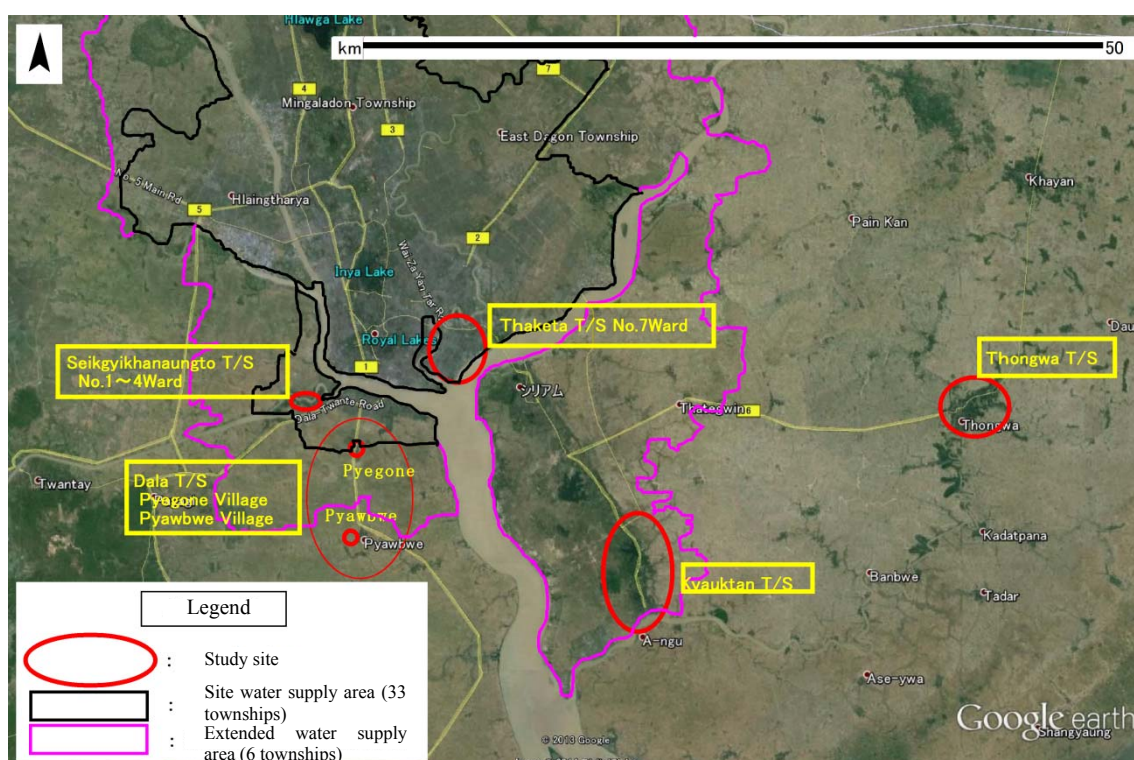
Cooperation between a third country/international organization and Pathein City in relation to the water supply sector could not be confirmed.

3. Study of the project

3.1 Yangon

3.1.1 Site survey

It is important to select sites for the project in areas where concerns of delay in water supply provision exist or isolated communities in the vicinity exist, after considering the interim provision targets in 2025 shown in the JICA Master Plan 2013 being formulated. At the start of the site study, discussions were held with YCDC, and candidate sites for the project were selected at six locations in line with the objectives of the project. Fig. 3.1 shows the candidate study sites.



Source: Ministry of Health, Labor and Welfare, Study Team

Fig. 3.1 Yangon candidate study sites

Table 3.1, Table 3.2 and Table 3.3 show the results of site studies and water quality inspections implemented with the cooperation of the counterpart.

Table 3.1 Results of Yangon site studies

Study site		25.ThaketaT/S	26.DalaT/S		21.Seikgyikhanaungto T/S	34.KyauktanT/S	Thongwa T/S
		No.1 Ward	Pyegone Village	Pyawbwe Village	Kanauntun (No.1~4 Ward>		
	Overview of site area						
Overview of area	The T/S is isolated by Bago River in the south and Ngamoeyek Creek in the north and west; Supply of tap water is at the end of the Gamock water treatment system. The served population ratio as in 2011 is 14%. This is low considering it is a township close to the center when compared to 38% for the whole of Yangon City. Target in 2025 is 45% according to JICA Master Plan 2013.	Located to the south of the Yangon River, sandwiched between the river and the Central Business District on the other side. Water supply is provided to 23 wards from the water supply facilities of YCDC. The target for 2025 is 45% in the JICA Master Plan 2013. There is no water supply to 23 villages to the south of the 23 wards. For domestic water supply to residents, pond water (rain water storage) is ensured (owned and managed by YCDC)	Located to the south west of Yangon River and to the south of the Twantay Canal. Sandwiched between the river and Ahlone T/S on the opposite side adjacent to CBD. Water supply is not available. Water is being supplied by pipes in raw form only to the Kanauntun (No. 1-4 wards) area from pond water (rainwater storage) managed and owned by YCDC. Water is not being supplied to the remaining 4 out of the 8 wards. Target in 2025 is 30% according to JICA Master Plan 2013.	One of the 6 T/S in the JICA Master Plan 2013 extended areas and a section outside the city at the southernmost end of W.S. area; water is not yet supplied. Water is being supplied by pipes in raw form to 6 of the 9 wards from pond water (rainwater storage) managed and owned by YCDC. Water is not being supplied to the remaining 3 wards. Target in 2025 is 10% according to JICA Master Plan 2013.	Although not included in the JICA Master Plan 2013 extended area, it is one of the sections outside Yangon City adjacent to east Thanlyin that YCDC desires; YCDC water is not being supplied. Water is being supplied by pipes in raw form to 8 of the 10 wards from pond water (rainwater storage) managed and owned by YCDC. For the remaining 2 wards, water from other pond (rainwater storage) is available for use as domestic water.		
	Population (study site:persons)	3,000	2,500	5,000	30,000	35,000	7,000
	Population (total: persons)	253,000	20,000 (only villages excluding YCDC water supply service area)		38,000	48,000	28,000
	Existing pipelines	Yes	No	No	Yes	Yes	Yes
	Treated water	YCDC tap water (no residual chlorine)	No	No	No	No	No
Water usage status							
	Rainy season	Rain water/ bottled water	Rain water	Rain water	Rain water	Rain water	Rain water
	Dry season	Pond water/bottled water	Pond water	Pond water	Pond water/bottled water (when pond dries up)	Pond water (Rain water, supply through pipe)	Pond water (Rain water, supply through pipe)
	Drinking water	Rain water consumed as-is or after boiling at all sites. Bottled water also purchased.					
	Domestic water	Rain water or pond water used as-is at all sites					
Water supply status							
	Facility managed by/Owner	YCDC					
	Water supply status	• YCDC water supply does not reach • Rain water, pond water through hand carts and purchase of 20-L bottle water	Volume satisfied by rain water and pond water	Volume satisfied by rain water and pond water	• Water supply sites at 12 locations with public water taps – water supply for 1 hour during day and night in the dry season, and purchase of river water sold by hand carts at each door	Water supplied to 6 out of 9 wards; no water supply for 3 wards, population of 1400 persons	Piped water supply to 1400 cases; remaining 4,500 cases for a total of 5900 cases.
	Tariff	• Water supply 88 Kyat/m ³ , 1,800 Kyat/month (for 2 cans, manual households) • Pond water free, hand cart 50-gallons 1,000 Kyat, 2—L bottled water 300-500 Kyat	• Pond water free • Pond water 18 L x 2 cans, manual transport: 100 to 200 Kyats per trip	Pond water free	YCDC supplied water such as pond water is free	Piped water supply: Fixed rate of 2500 Kyat/month per household	Piped water supply: Metered system, 220 gallons- 50 Kyat
	Results of site water quality tests	Both bacteria and E.coli due to health index detected (for details refer to table of results of water quality tests on site)					
Awareness of purchase of bottled water for drinking		20-L bottled water: Many households purchase at 300 to 500 Kyats	20-L bottled water: Households exist that want to purchase this water every day if price is 200 Kyats	20-L bottled water: Households exist that purchase at 500 Kyats	20-L bottled water: Households exist that purchase at 500 Kyats	20-L bottled water: Households exist that purchase at 400 Kyats	20-L bottled water: Households exist that purchase at 400 Kyats

Source: Ministry of Health, Labour and Welfare, Study Team

Table 3.2 Results of on-site water quality tests in Yangon

T/S	Test point	Turbidity (NTU)	pH	Na* (mg/l)	Common bacteria (unit/ml)	E. coli (unit/ml)
25.Thaketa	Raw water: No.7 Ward Pond	1.22	7.2	2	10and above	10and above
26.Dala Pyegone Village	Raw water: Aung Tha Pyay Pond	4.47	7.1	18	10and above	10and above
	Local House 1 (Private Pot)	6.56	7.1	4	10and above	10and above
26.Dala Pyawbwe Village	Raw water: Sin Thay Gyi Pond	2.85	7.2	16	10and above	10and above
	Raw water: Nat Sin Pond	1.21	6.6	5	10and above	10and above
	Local House 2 (Private Pot)	0.34	6.7	1	10and above	10and above
27.Sekgyikhanaungto 1-4 Ward	Raw water: Aung Mingalar Pond	7.35	6.4	8	10and above	10and above
Yangon River	Dala T/S side near ship berth	970.0	8.0	83	—	—
34..Kyauktan	Local House 3 (Private Well)	6.66	7.1	31	10and above	10and above
Thongwa	Raw water: Sin Kan Pond	1.43	6.7	4	10and above	10and above
	Local House 4 (Tap Water)	3.28	6.4	3	10and above	4
Water quality standards of Myanmar for drinking water (2011 Draft)		5	6.5 to 8.5	—	—	0

Source: Ministry of Health, Labour and Welfare, Study Team

Table 3.3 Analysis of water quality of pond water in Yangon

Results of water quality analysis

Sample name Sampled date			Dala T/S Pyabwwe Village Nat Sin Pond 12/12	Kyauktan T/S Sin Kan Pond 12/13	Thongwa T/S 31 Acres pond 12/13	Taketa T/S 7Ward Aung Min Galar Pond 12/13	WHO standards
NO.	Analyzed item	Unit					
1	Iron and its compounds	mg/L	0.16	0.27	0.58	0.05	0.30
2	Manganese and its compounds	mg/L	0.015	<0.005	0.089	0.012	0.100
3	Aluminum and its compounds	mg/L	<0.02	<0.02	0.04	<0.02	0.1-0.2
4	Cadmium and its compounds	mg/L	<0.0003	<0.0003	<0.0003	<0.0003	0.003
5	Lead and its compounds	mg/L	<0.001	<0.001	<0.001	<0.001	0.01
6	Arsenic and its compounds	mg/L	<0.001	<0.001	<0.001	<0.001	0.01
7	Copper and its compounds	mg/L	<0.01	<0.01	<0.01	<0.01	2
8	Mercury and its compounds	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	0.006
9	Dissolved iron and its compounds	mg/L	<0.01	0.01	<0.01	<0.01	
10	Dissolved manganese and its compounds	mg/L	<0.005	<0.005	<0.005	<0.005	
11	Alkalinity	mg/L	20.0	27.6	14.1	14.5	
12	Color	Deg.	6.7	5.1	6.1	3.6	15
13	Calcium, magnesium, etc. (hardness)	mg/L	15.0	27.5	11.4	11.0	
14	Fluorine and its compounds	mg/L	<0.05	<0.05	<0.05	<0.05	1.5
15	Chloride ion	mg/L	2.0	7.0	1.1	0.6	250.0
16	Organics (Total Organic Carbon quantity)	mg/L	3.4	2.9	2.9	2.7	
17	Ammonia nitrogen	mg/L	<0.05	<0.05	<0.05	<0.05	
18	Total dissolved solids	mg/L	18.0	50.0	3.0	16.0	600.0
19	pH		6.6	7.1	6.7	7.2	Japanese standards (5.8-8.6)
20	Turbidity	NTU	1.2	6.7	1.4	1.2	1
Judgment			○	○	○	○	
Soluble matter that cannot be removed by ceramic membrane (pore diameter: 0.1 μm) in the substance included in raw water at four points satisfy the WHO drinking water quality standards. Consequently, water becomes drinkable after ceramic membrane treatment process.							

Source: Ministry of Health, Labour and Welfare, Study Team

For this project, the diffusion of water supply is inadequate in the service areas of JICA Master Plan 2013 even in 2025 slightly more than ten years in the future. Even now, areas for which access to safe drinking water is difficult are considered in this project, and the following were summarized based on the study results:

- YCDC owns and manages rainwater storage ponds in the project candidate sites at six locations. The residents of the areas are using the pond water as drinking water and for domestic use without treatment and without chlorine injection.
- The quantity of drinking water used by a family of 5 persons is about one 20-l bottle every two days (rate of 2 l/day.person).
- Results of water quality inspections showed the presence of common bacteria as well as *E. coli* in raw water (pond water), private rainwater reservoirs, private wells, and private draw-off taps (see Table 3.2). When providing water for drinking, efforts are required to avoid risks from hygienic aspects by adopting independent measures such as by boiling the water. However, water is consumed as-is without boiling in many cases to minimize fuel costs; so ensuring safe drinking water is not foolproof.
- Water quality of pond water in the study area was analyzed and its water treatment level checked by a Japanese inspecting organization. It was confirmed that the dissolved substances that could not be removed by ceramic membrane, which is a mobile water purifier, satisfied the WHO drinking water quality standards (see Table 3.3).
- Although 25.Thaketa T/S is in the YCDC service area, service ratio in 2011 is 14%, and this is comparatively low considering the T/S of 50% or more in the adjacent region upstream. This is attributed to the insufficient absolute water supply quantity from YCDC and the shortage in distribution capacity due to the inadequate provision of pipelines. To cope with the shortage in drinking water and domestic water, water from private wells, water from water vendors and bottled water is being used. However, a target service ratio of 45% is being aimed for in 2025 according to JICA Master Plan 2013. To supply drinking water to about 250,000 persons (2011), the introduction of mobile water purifiers will not be efficient; entrusting the provision of water supply according to JICA Master Plan 2014 would be a good plan.
- For the remaining five project candidate sites, rain water is mainly being used as drinking water, and the water from ponds owned and managed by YCDC is being used as-is (untreated raw water) as domestic water. Rain water is not available in the dry season; therefore, either the supernatant water of ponds is used as drinking water or bottled water is purchased.

Depending on the dry season, ponds may dry up completely (occurred in Seikgyikhanaung to T/S Kanaunton; bottled water from donation used to cope with this problem), so care needs to be taken to check the capacity of pond facility.

Regarding the pond water supply method, (1) Transmission by pipeline: 3 sites; (2) Transportation of water by hand carts and by poles carried on shoulder: All areas in 6 sites except where water is supplied by pipelines.

- Regarding pond water tariff, Kyauktan T/S with water supply through pipelines: 2,500 Kyats/month (250 yen/month) and Thongwa T/S: 50 Kyats/m³ (5 yen/m³), 220 gallons; at all other sites, pond water from ponds owned and operated by YCDC and owned by temples is free of charge.

Transportation of pond water for domestic use, 50-gallon handcart: 500-1,000 Kyats (50-100 yen)/cart; 20 L x 2 poles carried on shoulder: 100-200 Kyats (10-20 yen)/trip.

- Bottled water of 20-l capacity costs 300-600 Kyats (30-60 yen) per bottle; the price varies depending on the area, distance, and whether the season is rainy or dry. It was confirmed that the will to buy was stronger when the cost was about 200 Kyats (200 yen) per bottle (1,000 yen/m³). Table 3.4 shows the comparison of water costs.

Table 3.4 Comparison of Yangon water costs

Item	Cost
Drinking water (20-l bottle including cost of delivery)	300-600 Kyats/bottle (15,000-30,000 Kyats/m ³ : 1,500-3,000 yen/m ³)
Domestic water (treated water and chlorine injected) (cost for delivery of 50-gallons (227-l) by handcart)	600-1,000 Kyats/bottle (2,600~4,400 Kyats/m ³ : 260-440 yen/m ³)
Domestic water (treated water and chlorine injected) (cost for delivery of 20 l x 2 by poles carried on shoulder)	100-200 Kyats/container (2,500-5,000 Kyats/m ³ : 250-500 yen/m ³)
Domestic water (treated water and chlorine injected) (Kyaukutan T/S pipe water supply)	2,500 Kyats/month. household (YCDC normal household average result 17.8m ³ / month) (140 Kyats/m ³ : 14 yen/m ³)
Domestic water (treated water and chlorine injected) (Thongwa T/S pipe water supply)	50 Kyats/ 220 gallons (4.546 L/gallon) (50 Kyats/ m ³ : 5 yen/ m ³)
YCDC water tariff (normal household: normal) (Revised in April 2012)	Meter rate system: 88 Kyats (9 yen)/m ³ Fixed rate system : 1,800 Kyats (180 yen)/month [Water tariff per m ³ in fixed rate system (taking average consumption for common household as 17.8 m ³ /month) 101 Kyats (10 yen)/m ³]

Taking conversion rate as 1 yen= 10 Kyats

Source: Ministry of Health, Labour and Welfare, Study Team

3.1.2 Project plan for Yangon

1) Selection of the study area

From the site study results of Table 3.1, it was confirmed that the population of 253,000 persons of 5 T/S were using rain water and pond water (rain water storage) as drinking water and domestic water. Although it was surmised based on interviews of residents that persons boiling rain water and using it as drinking water were numerous, there were also persons who drank the rain water without boiling it or the pond water as-is. These problems came to light after the water quality inspections (common bacteria and E. coli were detected at all sites) on site.

Of the 5 candidate projects (service areas), service area 25 (T/S Code) of YCDC, Taketa T/S and 26 (T/S Code), Datal T/S 23 Wards will be entrusted to the measures to be adopted in JICA Master Plan 2013.

Consequently, the 3 T/S for which the served population targets as set in JICA Master Plan 2013 have low levels as shown in Table 3.5 and given below:

- Village areas (served population targets unconfirmed) excluding 26 (T/S Code), Dala T/S 23 Wards
- 27 (T/S Code), SeikgyiKhanaungto T/S(30%),
- 34 (T/S Code), SeikgyiKhanaungto T/S(10%),

and the following T/S located outside the service area (see Fig. 3.1) about 15 km to the east of the Kyauktan T/S:

- Thongwa T/S

are selected as the study areas, and the contents of the plan to supply drinking water using mobile water purifiers will be studied from the aspects of ensuring safe drinking water.

Table 3.5 gives an overview of the said projects and Fig. 3.2 shows an illustration of the water supply systems.

Table 3.5 Overview of Yangon Projects

Service area	Overview of project
26.Dala T/S (South Yangon District)	Study: Supply of drinking water to about 20,000 persons populating 23 villages excluding the YCDC water supply (23 wards) Water sources: Ponds owned and managed by YCDC Treatment system: Mobile water purifiers (mobile) Water supply system: (3) Water source – treated water (mobile) – Elevated tank – public tap
27.Seikgyi - Khanaungto T/S (South Yangon District)	Study: Supply of drinking water to the scale of 38,000 persons (YCDC 2011) populating a total of 8 wards Water sources: Ponds owned and managed by YCDC Treatment system: Stationary water purifier (area required adjacent to water source since road is narrow) and mobile water purifier Water supply system: No. 1 to No. 4 wards ① Water source – treated water (stationary) – elevated aqueduct – pipes for carrying drinking water – public taps No. 5 – No. 8 Wards ③ Water source – treated water (mobile) – elevated water tank – public tap
34.Kyauktan T/S (Districts outside Yangon City)	Study: Supply of drinking water to about 48,000 persons (of which 35,000 persons to receive piped water supply) Water sources: Ponds owned and managed by YCDC Treatment system: Mobile water purifiers (mobile) Water supply system: Piped water service area ② Branch from existing pipelines – treated water (mobile) – elevated water tank – public taps. Other areas ③ Water source – treated water (mobile) – elevated water tank – public taps
Thongwa T/S (Districts outside Yangon City) : Extended outside 6 service areas	Study: Supply of drinking water to about 48,000 persons (of which 35,000 persons to receive piped water supply) Water sources: Ponds owned and managed by YCDC Treatment system: Mobile water purifiers (mobile) Water supply system: Piped water service area ② Branch from existing pipelines – treated water (mobile) – elevated water tank – public taps. Other areas ③ Water source – treated water (mobile) – elevated water tank – public tap
Unit drinking water units	2L/person. day ^{*1}

*1: Status confirmed by interviews of residents during site study (One 20-L bottle every 2 days for a 5-person family)

Water supply system ① ② ③ : Refer to Fig. 3.2 for illustration of water supply system

Source: Ministry of Health, Labour and Welfare, Study Team

2) Overview of plan

Based on the information obtained during site study this time, the scale of the plan, water sources, water supply system and overview of facilities were studied, approximate project costs, and operation and maintenance costs were worked out. Table 3.5 gives the plan overview and Fig. 3.2 shows an illustration of the water supply systems.

The present plan aims to supply drinking water to the residents at this juncture; therefore, the plan is based on the population as of 2011 without considering future population increase.

The procurement of purifier, a key component for this project is likely to be made from Japan, which has abundant experience and good reliability in manufacturing this product. Technology transfer is anticipated to be given through training during general trials and operation and control at the time of handing over of the equipment. Procurement of other equipment is likely to be made locally considering cost reduction.

Considerations are also necessary for establishing a cooperative system for stable supply of water such as support for maintenance and inspection once a year.

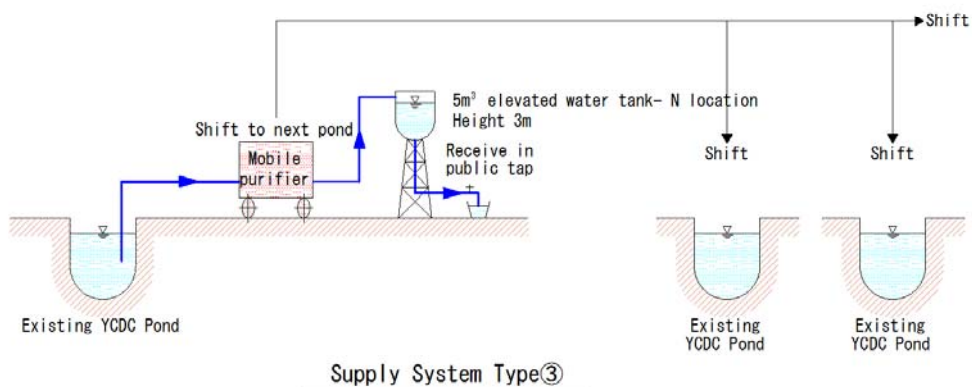
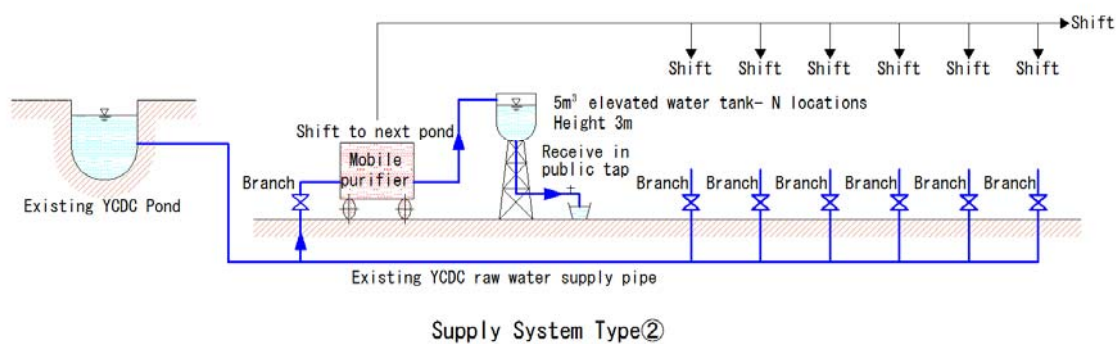
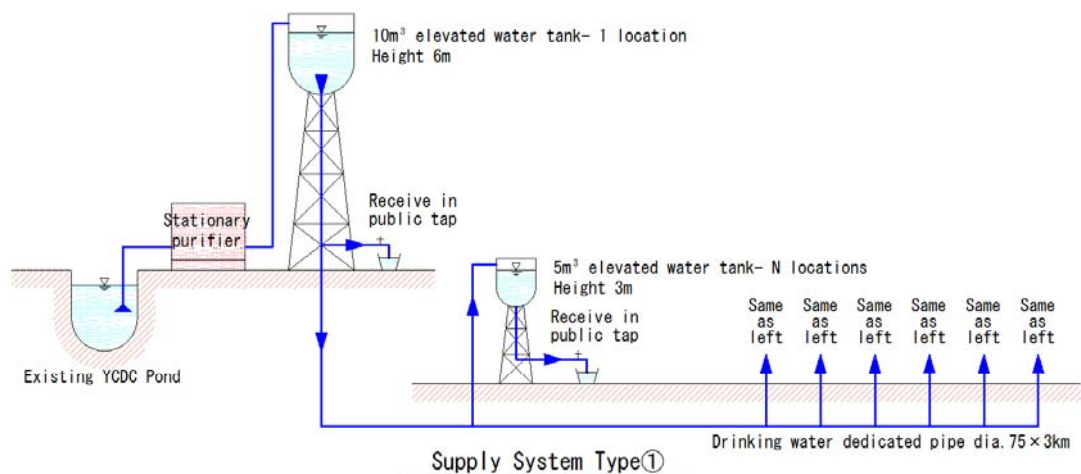
Table 3.6 Overview of Yangon Plan

Type/Item/Condition	South –West Group		South-East Group	
	26.Dala T/S 23Villages	27.Seikgyi k hanaungto T/S	34.Kyauktan T/S	Thongwa T/S
1. Scale of plan				
Total population (persons)	20,000	38,000	48,000	28,000
Piped water supply	0	30,000	35,000	7,000
Pond water	20,000	8,000	13,000	21,000
Drinking water scale (m ³ /d)	40	76	96	56
Piped water supply	0	60	70	14
Pond water	40	16	26	42
2. Water source	Pond water (owned/managed by YCDC)	Pond water (owned/managed by YCDC)	Pond water (owned/managed by YCDC)	Pond water (owned/managed by YCDC)
3. Water supply system				
① Water source - treated water (stationary) -elevated water tank - Pipes for drinking water - (elevated water tank & public tap)	-	10m ³ elevated water tank at 1 location	-	-
② Existing pipe branch - treated water (in-vehicle) - (elevated water tank public water tap)	-	-	5m ³ elevated water tank and public tap x 15 locations	5m ³ elevated water tank and public tap at 4 locations
③ Water source – treated water (in-vehicle) (elevated water tank public tap)	5m ³ elevated water tank and public tap at 10 locations	5m ³ elevated water tank and public tap at 10 locations	5m ³ elevated water tank and public tap at 5 locations	5m ³ elevated water tank and public tap at 8 locations
4. Outline of facilities				
① Stationary purifier (capacity:120 m ³ /d) :12-hour operation per day	-	1 no.	-	-
② Stationary purifier (capacity:200 m ³ /d) : 6-hour operation per day	2 no.	2 no. (1 spare) *1	4 no. (1 spare) *2	2 no.
③ 10 m ³ elevated water tank (6-m ht. with public tap)	-	1 location	-	-
④ 5 m ³ elevated water tank (3-m ht. with public tap)	10 locations	10 locations	20 locations	12 locations
⑤ Pipelines for drinking water	-	φ75 × 3 km	-	-
⑥ Tanks (20-L plastic tanks, about 40% of households)	1,500	2,800	4,800	2100
5. Approx. total project cost (unit: 1000 yen)	712,000			
Estimation conditions (2013 cost level)	① Site costs not yet accounted (assuming YCDC will make arrangements) ② Purifier imported (duties not accounted) ③ Others locally procured			
Approx. project cost (unit: 1000 yen)	127,000	201,000	255,000	129,000
6. Approx. O&M cost (unit: 1000 yen/year)	31,800			
Estimation conditions (2013 cost level)	① Labor cost (3 members in 1 purifier team) ② Quality of chemicals (PAC, hypochlorite) ③ Fuel (Diesel generator and truck) ④ Repair costs/total labor cost ⑤ Purifier maintenance and inspection costs (Japan – site)			
O&M cost (unit: 1000 yen/year)	6,200	8,600	10,300	6,700
7. Cost estimation				
① Annual drinking water capacity (m ³ /y) total 97820 m ³ /y	14,600	27,740	35,040	20,440
② Mean capital cost (yen/m ³)	① Remainder 10% depreciation 16 years ② Interest cost, import duties, etc., not included			
Calculation conditions	409 20-L bottle conversion (90 Kyats/bottle)			
Capital cost (yen/m ³)	489	408	409	355
③ Mean O&M cost (yen/m ³)	325 20-L bottle conversion: 6 yen/bottle (60Kyats/bottle)			
O&M cost (yen/m ³)	425	310	294	328
④ Mean total cost (yen/m ³)	735 20-L bottle conversion: 15 yen/bottle (150 Kyats/bottle)			
Total cost (yen/m ³)	914	718	703	683

Note: 4. Overview of facilities *1: South-West Group common spares *2: South-East Group common spares

Note: Taking conversion rate as 1 yen= 10 Kyats

Source: Ministry of Health, Labour and Welfare, Study Team



Source: Ministry of Health, Labor and Welfare, Study Team

Fig. 3.2 Illustration of water supply systems

3) Comparison of preliminary estimated drinking water cost, commercial water bottle cost, etc., and YCDC water tariff

Table 3.7 shows the comparison of preliminary drinking water cost and commercial water bottle cost, etc., based on the plans of the Project, with the YCDC water tariff (revised in April 2012). If the cost necessary for ensuring water supply to the residents in the study area is compared with the water cost for the Project, domestic water is at the preliminary O&M cost level of the Project (however, water supply is untreated water supply), and commercial 20-L bottled drinking water is more than two times the preliminary total cost.

Table 3.7 Comparison of Yangon preliminary drinking water cost, commercial water bottle cost, etc., and YCDC water tariff

Type	Amount	Summary
Drinking water supply (m ³ /year)	97,820	$(40+76+96+56) \text{ m}^3 \times 365 \text{ days}$
Total project cost (x 1,000 yen)	712,000	¥127,000+¥201,000+¥255,000+¥129,000
Annual O&M cost (x1000 yen/year)	31,800	
Drinking water cost per m³		
① Capital cost (yen/m ³)	409	Assuming residual value as 10% and service life (equipment) as 16 years
② O&M cost (yen/m ³)	325	Median cost of 50 gallons of pond water by hand cart (260-440 yen/m ³) $(31,800 \div 97,800 \text{ m}^3) \times ¥1,000$
③ Total cost (①+②) (yen/m ³)	735	About half the cheaper level of cost (1500-3000 yen/m ³) of 20-L bottled water (including delivery charges)
YCDC water tariff		
Common household commodity charge (yen/m ³)	9	88Kyat/m ³ (Tariff set by administration; full cost (including capital cost) is not recovered. Chlorine injection is inadequate; leakage is high, etc., so repair costs cannot be taken even from O&M viewpoint).

Exchange rate: 1 yen=10 Kyats

Source: Ministry of Health, Labour and Welfare, Study Team

4) Implementation scheme

Supply of drinking water is required public nature from hygiene aspects as well. The Project should preferably be managed in a implementation scheme that considers this point.

Three implementation schemes that can be assumed based on the degree of participation of the public are compared in Table 3.8 Based on the individual project features from the study results this time, the probability of a Public Private Partnership type of implementation scheme is high.

Table 3.8 Comparison of Yangon Implementation schemes and Probability of its Realization

Implementation scheme	Features	Probability
Public Mgmt.	<ul style="list-style-type: none"> • Compared to the initial investment of about 700 million yen, the scale too small for the ODA loan. • Probability is low since grant aid project is simultaneously ongoing in Yangon. • In YCDC, the scale of capital expenditure is small at about 500 million yen (2011/2012 results), and probability of realization is small. • Compared to the preliminary O&M cost estimation of 325 yen/m³ and overall cost of 735 yen/m³ (capital cost + O&M cost), the general household tariff is 9 yen/m³ (88Kyats/ m³) which is an issue (revision of tariff system, etc., to eliminate the difference in existing tariff without full cost recovery). 	Medium
PPP	<ul style="list-style-type: none"> • Water supply service area is under YCDC jurisdiction, and public operability is guaranteed when YCDC participates. • Business should preferably be managed by three parties namely YCDC, local company, and Japanese company as the main implementing body, and their roles are as below. YCDC : Aim for a model business by supplying safe drinking water/ participate in business until water supply is provided; take the role of development to other similar areas. Local company : Participate in local business activities through a cooperative system with YCDC, with Japanese Company offering technical expertise. Japanese company : Capacity Development of Private local Companies related with water supply system through this scheme. 	High
Private Mgmt.	<ul style="list-style-type: none"> • Duplication in relevant service areas with YCDC; work is restricted by YCDC's water supply policies. • Unstable components of business exist such as competition with existing local water vendors. • Status is such that quantity and selling price cannot be determined. 	Low

Exchange rate: 1 yen=10 Kyats

Source: Ministry of Health, Labour and Welfare, Study Team

Furthermore, the points below need to be clarified for promoting the business. A close examination of business profitability will become key to the success of the project.

- Existence of subsidies for initial investment (elimination of viability gap)
- Interest level of public or private loan
- Understanding preferential custom duties for import of materials and equipment
- Price settings that will ensure that business is not in the red
- Number of years for recovery of capital cost (preliminary estimate, taking residual value as 10%, and service life of equipment as 16 years)
- Checking the will to purchase drinking water at the set price and setting the scale of the business

- Studying the possibility of forming a cooperative system with local water vendors (stakeholders)

The budget from various perspectives (JICA, etc.) of Japan will be used henceforth, and feasibility study carried out to move to the next step.

3.2 Pathein City

3.2.1 Site survey

Pathein City does not have a modern water supply system, and no responsible organization with expertise related to water supply exists in the Pathein Township Development Committee. Consequently, the Water Supply Board must be set up immediately and the management skills fostered in order to provide a water supply system for Pathein City.

Development of the full-fledged water supply system entails enormous cost and time; on the other hand, the supply of safe drinking water is an urgent task. Accordingly, it was considered effective that the Water Supply Board starts developing the piped water supply system, and in parallel, introduce mobile water purifiers that can be utilized within a short period, and start supply of safe drinking water in some areas. Moreover, it was also considered as effective training for full management for the future full-fledged water supply system to accumulate experiences in such small-scale water supply management through installation of water meters and introduction of service charge collection in some areas.

In view of these circumstances, water quality inspections were carried out and water sources were studied for the three candidate locations (of which two locations were the same as the water sources for the piped water supply) for mobile water purifiers. And the Pathein River and Daga River (see Fig. 3.3), were also inspected for the piped water supply systems. Table 3.9 shows the results of these important water quality tests.

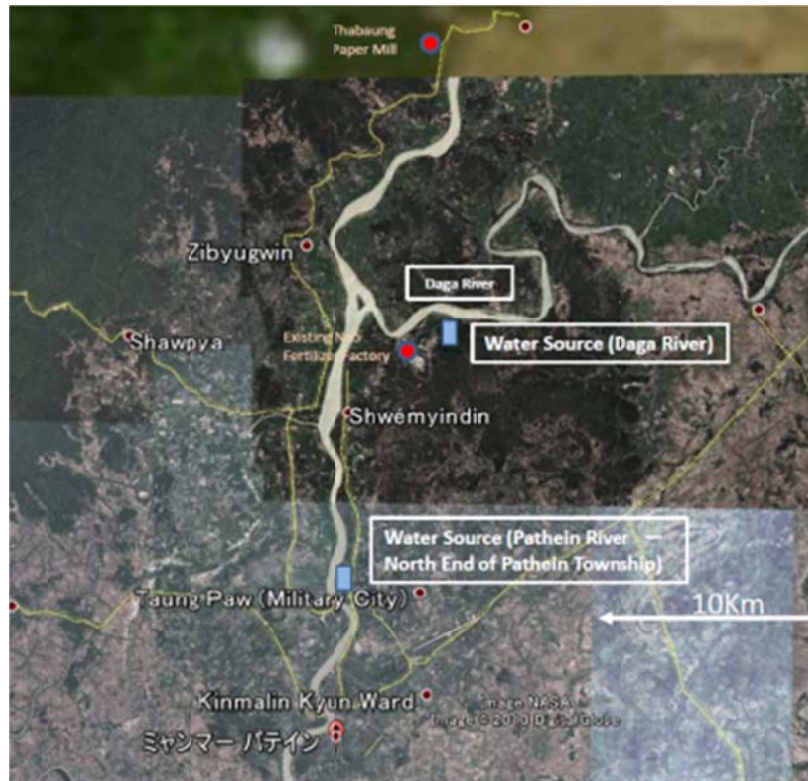


Fig. 3.3 Location of water sources for water supply to Patheingyi City
(Patheingyi City, Daga River)

Table 3.9 Water quality test results

Test point	Turbidity (NTU)	pH	Iron and its compounds	Aluminum and its compounds	Color	Chloride ion
Pathein River	100.0	8.1	1.20	0.7	18.6	3.0
Daga River	113.0	8.1	2.01	1.03	39.9	2.9
Royal Lake	13.5	8.6	0.24	<0.02	6.2	3.0
WHO Water Quality Standards	5	5.8-8.6	0.3	0.1-0.2	15	250

Source: Ministry of Health, Labor and Welfare, Study Team

Water quality test results showed that values of iron content, aluminum and color were high. However, iron content and aluminum existing in surface water are generally suspensions; moreover, the high value of color is attributed to the iron content. Usually, the suspensions of iron content and aluminum can be treated during the coagulation-sedimentation and filtration stages, and a treatment system using rapid sand filter is considered effective for this purpose. However, if the detected aluminum is soluble, treatment using the conventional filtration system may not be possible; therefore, detailed studies may be required in the future. Of the two rivers that are candidate water sources for the piped water supply system, Daga River is located more upstream than the Pathein River. Therefore, water quality of the Daga River is generally considered better than that of the Pathein River, but water quality tests show that to a small extent, the turbidity of Pathein River is lower than that of Daga River. In case of Pathein River, salt water intrusion is a cause for concern; however, results of water quality tests this time did not show any effect of salt water intrusion. Since a chemical fertilizer plant and pulp and paper plant are located 10 to 20 km upstream of the Pathein River, quality of the river water is also a cause for concern. However, in this case also, water quality tests showed no adverse effects. Accordingly, no issues are anticipated taking Pathein River as a water source at this point of time; however, before taking the final decision, further water quality studies including collection of all-year data are necessary. If the water quality of Pathein River deteriorates in the future, at that point of time, the water source can be switched over to the Daga River.

3.2.2 Project plan for Pathein

The four items below were proposed for inclusion in the plan required for improvement of Pathein water supply. The overview was given for each proposal, and the implementation schedule of the overall plan was also proposed.

- (1) Establish the Water Supply Board
- (2) Start developing the piped water supply facilities
- (3) Introduce mobile water purifiers and supply safe drinking water until the piped water supply facilities are provided

- (4) The newly established Water Supply Board to conclude Management Contract with international water operator to manage the water supply project at a level of international standard from the beginning.

(1) Establish the Water Supply Board

Establish the Water Supply Board under the Patheingyi Township Development Committee or the Ayeyarawady Regional Government.

(2) Provision of the piped water supply facilities

The accurate population of Patheingyi City cannot be established until the census results anticipated in 2014 are published. However, the plan was made based on the figure (139,000 persons) given by the Patheingyi City officials. The City is divided into 15 wards, and is also divided into the eastern and western parts by the Patheingyi River. About 90% of the population is concentrated in the east bank area of the Patheingyi River. For the installation of water supply facilities, the east bank area will be divided into two phases, the first phase covers the central city area (Area 1) and the second phase covers the areas around the central city area (Areas 2, 3). The population density in the west basin area (Area 4) is low, and this area is distant from the water treatment plant; therefore, it will be covered by mobile water purifiers in the future as well. Fig. 3.4 shows the master plan of water supply areas of Patheingyi City, while Table 3.10 gives the overview.

The water treatment plant is to be constructed on land owned by the Ports and Harbors Bureau on the east basin of Patheingyi River at the north end of the Patheingyi City area. The scale of water treatment is 18,000 m³. Rapid sand filtering system shall be applied considering the water quality (turbidity, etc.) of raw water.

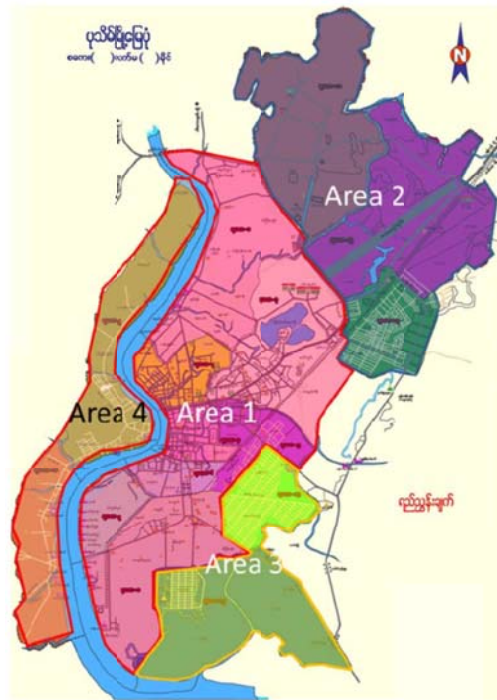


Fig. 3.4 Master plan water supply areas in Patheingyi City

Table 3.10 Overview of Master Plan water supply areas in Patheingyi City

Area	Population	Ward	Phase
1	99,049	1, 2, 3, 4, 5, 6, 7, 8	Phase-1
2	14,229	11, 13, 15	Phase-2
3	11,150	12, 14	Phase-2
4	14,249	9,10	Mobile water purifier
Total	138,677		

(3) Mobile water purifier

The introduction of mobile water purifiers in the three areas shown in Fig. 3.5 and Table 3.11 after considering the status of water sources. The water quality of water sources is as given in Table 3.9 of Sec. 3.2.1. Although iron content and aluminum are considered as suspensions, detailed water quality examinations must be conducted in the future. Since soluble items cannot be removed by membrane (pore diameter: 0.1 μm), if the raw water has soluble items, either the further treatment process must be added or the water source must be changed.

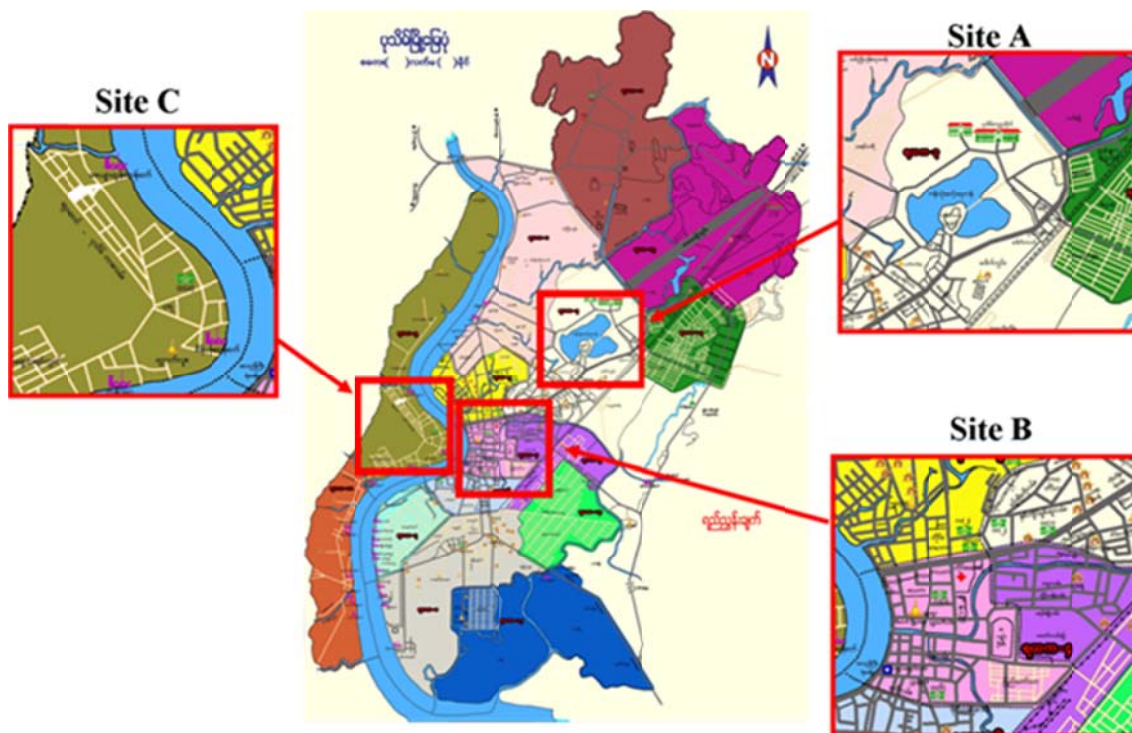


Fig. 3.5 Areas for provision of mobile water purifiers in Patheingyi City

Table 3.11 Overview of areas for provision of mobile water purifiers in Patheingyi City

Name of area	Water source	Population (persons)	Flow rate (m ³ /day)
Site A : Around Royal Lake	Royal Lake	1,500	30
Site B: Around the east coast of Patheingyi River	Patheingyi River	1,500	30
Site C: Around the west coast of Patheingyi River	Patheingyi River	1,500	30

(4) Management Contract with international water operator

In regard to the O&M and management of the water supply as mentioned above, the introduction of international level of management from the beginning was proposed in this study. It is considered to be realized by the mutual cooperation between the Water Supply Board which is established either in the Patheingyi Township Development Association or Ayeyarawady Regional Government and an international water operator through a Management Contract for a limited period.

Management Contracts are widely used as the most basic form of PPP in the water supply business in developing countries.

In case of the Management Contract, Newly established Water Supply Board should contract the water supply facilities as the public sector. Private water supply operators will operate and

manage the Water Supply Board and its water supply facilities for a specific limited period (5 years, etc.), and receive management fees. Private water supply operators will not be burdened with tariff risk which means the risk for financial vulnerability based on low tariff etc. will be borne by public sector.

In comparison with full-fledged PPP such as the Concession scheme, the Lease scheme and the BOT scheme of which regulatory framework is necessary for introducing, the “Management Contract” is more suitable to encourage private sector to enter into the water supply operation in countries which have high tariff risk, inadequate regulatory framework for the PPP and so on.

Especially, for the newly established Water Supply Board in Patheingyi City to become proficient in skills for managing and operating a newly provided piped water supply system within a short period, the effective actions are to introduce mobile water purifiers and start a small scale water supply operation, and from this stage onward, implement the project jointly with international water operator through the Management Contract.

Yokohama Water Company has evinced keen interest in participating in the PPP of Patheingyi City Water Supply Project through this Management Contract.

3.2.3 Main components of the Project

Table 3.12 shows the main components of the proposed Patheingyi City Water Supply Project.

Table 3.12 Main components of the proposed Patheingyi City Water Supply Project

Component	Approx. cost	Remarks
Provision of the piped water supply system (18,000m ³ /d)	3,000 mil. Yen	Presumed to be divided into phases
Introduction of mobile water purifiers (200m ³ /d × 3 units)	190 mil. Yen	
Management Contract with international operator (Such as Yokohama Water Company)	100 mil. Yen	Two-stage implementation (3 years + 5 years)

3.2.4 Project implementation schedule

Table 3.13 shows the annual implementation schedule of the proposed Patheingyi City Water Supply Project.

Table 3.13 Annual implementation schedule of the proposed Patheingyi City Water Supply Project

Donor Assistance and/or Government Budget			
↓ ↓			
Ayeyarwady (Patheingyi) Water Supply Board			
2014	2014-2019	2019-2024	2024-
-Procurement of mobile ceramic membrane filtration equipment -Establishment of Water Supply Board	-Development of piped water supply system for 70,000 population -Safe drinking water supply by operating mobile ceramic membrane filtration equipment	-Piped water supply for 70,000 population -Development of remaining for 70,000 population	-Piped water supply for 140,000 population
16 staff	16 staff ⇒ 74 staff	74 staff	106 staff

↑ Advisory Contract
(2015-2017)

Yokohama
Water
Company

↑ Management Contract
(2018-2022)

Myanmar Water Supply Service

↓

Joint Venture ↓

Yokohama Water Company

Myanmar Company

4. Items related to effects and impacts of proposed project plan

4.1 Yangon

4.1.1 Effects of project implementation

Yangon is working toward the target year of 2025 for provision of water supply in line with the JICA Master Plan 2013, which is being formulated.

Targeted areas in this study are situated on area where the effects of JICA Master Plan 2013 are unlikely to reach even in the target year of 2025, and rain water or raw water from ponds where rain water accumulates will be used as drinking water. In such areas, common bacteria and E. coli were detected during water quality inspections at site study. The region is facing risks in hygiene, and economically well-to-do residents are looking for safe drinking water in bottled water.

Therefore, to supply safe drinking water for such disadvantaged area is expected to have great effect.

4.1.2 Impact of project implementation

None-Chlorine-injected tap water is currently being supplied in Yangon City. Residents are making self-help efforts to ensure safe drinking water by using bottled water, boiled water and so on. However, issues are likely to be resolved during the water supply provision period given in JICA Master Plan 2013.

However, a considerable amount of time is necessary before whole areas under this Project receive the benefits. The socio-political impact of ensuring safe drinking water to even a part of the area where this Project is to be implemented and the avoidance of risks from hygienic aspects in this period is high. Solutions to issues in this Project are anticipated to be applied in many similar areas as the Project areas that exist on the outskirts of metropolitan water supply area, and the technical impact is likely to be large. Moreover, economic impact on the YCDC side due to projects in which new technologies are introduced, diplomatic and publicity impacts on the Japanese side, and furthermore, overseas development by Japanese companies are anticipated.

4.2 Patheingyi City

4.2.1 Effects of project implementation

Patheingyi City does not have a modern water supply system and enormous cost and time are required to install a full-fledged water supply system. To cope with that situation, the mobile water purifier, which can be introduced in a short time and is easy O&M, will be effective to

supply drinking water to some areas earlier.

4.2.2 Impact of project implementation

By implementing this project, not only safe drinking water will be supplied to a part of this area, but also advanced management conforming to international standard can be performed from the beginning of water supply thorough O&M, tariff collection, deliberate business operation etc. under the Management Contract with an international water operator.

Similar to Yangon, the socio-political impact is high for ensuring safe drinking water to even a part of the areas where this Project is to be implemented and the avoidance of risks from hygienic aspects. Instances of this Project are anticipated to be applied in service areas, and the technical impact is likely to be large. Moreover, economic impact on Patheingyi City due to projects in which new technologies are introduced, diplomatic and publicity impacts on the Japanese side, and furthermore, overseas development by Japanese companies are anticipated.

5. Evaluation proposed project

5.1 Yangon

5.1.1 Institutional adequacy and sustainability when major alternatives and the projects are implemented

1) Major alternatives

YCDC endorses the promotion of JICA Master Plan 2013 presently being formulated, and does not have any alternative plan for supplying drinking water as a quick solution in the area under study. However, it is adequately aware of the necessity of ensuring safe drinking water, and has shown keen interest in realizing this project.

2) Institutional adequacy and sustainability when the project is implemented

YCDC water supply including the water supply for this project area is being operated and managed by the Department of Water and Sanitation with 2162 employees (as in June 2012) and six divisions, as shown in Fig. 2.5 in Sec. 2.3.2. As of 2011, it has the responsibility to supply water to a served population of about 1,920,000 persons at an average rate of 610,000 m³/d.

The mobile water purifier system proposed in the Project is the first one to be introduced in YCDC. Employees may be endowed with operating and managing skills by handing-over training and by improving the operation and management support system during the operating period (entrustment of support to the procurement source, etc.). Person in charge of water supply are stationed even now at the project areas; considerations for re-organization with the increase in duties may be necessary.

5.1.2 Financial conditions when the project is implemented

Concerning the YCDC's budget operating procedure, all revenues are to be paid to the government of state/region or Central Government and after submitting the budget plan, the budget amount approved by the Central Government is to be received by YCDC from the government of state/region. As a result, YCDC has very little freedom in deciding how profits are used. The right to take self-decisions on capital expenses such as investment on equipment does not exist; approval must be received from an executive committee.

From the fiscal balance for the Department of Water and Sanitation in 2011/2012, the current account revenue amounts to about 4700 million Kyats, and 93% of the current account revenue is due to profits from water supply. The current expenditure is about 4500 million Kyats indicating a slight current account surplus. However, based on the trend of increase of expenditure in the past, there is concern that this current account balance may collapse in the near future. Although at a glance, the income and expenditure seem to be balanced presently, the

expenditure for chlorine injection indispensable for safe tap water supply and for controlling the correct water pressure is inadequate. Moreover, depreciation cost for capital cost recovery is not included. Incidentally, the unit expenditure of 66 Kyats/m³ based on the estimated consumption in 2011 (68 million m³/year) is 75% of 88Kyats/m³ of average water tariff for common household at a meter-rate revised in April 2012. However, it is not enough to accumulate capital for investment on large facilities and equipment.

Capital expenses such as equipment investment are allocated from special accounts of the Central Government after October 2011. Capital expenses of the Department of Water and Sanitation for 2011/2012 amount to about 4700 million Kyats; however, equipment investment is expected to show an increasing trend with the progress in the Project of JICA Master Plan 2013 henceforth. For this Project, preliminary estimate of equipment investment is about 7000 million Kyats. For ensuring this amount, studies on tariff system with the supply of safe drinking water, improvement of subsidy system for equipment investment, and utilization of ODA (grant aid, loans with low interest, etc.) are necessary.

5.1.3 Technical validity and sustainability when the Project is implemented

Japan has a good track record of membrane filtration. The water treatment process should be simple, treatment has high reliability even if fluctuations exist in raw water quality, equipment is capable of automatic operation, O&M is simple and reliability is high.

The water supply in the project area, where rainwater storage ponds are scattered, and electricity supply is unreliable, requires mobile water supply facility and off-grid power system. In accordance with such condition, the mobile water purifier which meets these requirements is introduced in this project.

YCDC currently has large-scale facilities for water source, water conveyance, water treatment, water transmission, water distribution and water supply. They are striving hard to improve the technical skills of employees in the operation and maintenance of these facilities. In this Project, safe drinking water will be supplied steadily and continuously while taking necessary measures such as acquiring O&M techniques for the mobile water purifier during handing-over training, assistance for O&M support system (for instance, annual maintenance and inspection contract with the procurement source), ensuring repair costs, etc.

5.1.4 Environmental considerations

Environmental impact as mentioned below may be envisaged for this project. Response to the effects of the impact will be taken during project implementation.

- Pond resource utilization : Response to effects on pond users
- Land expropriation and involuntary resettlement

: Response to avoid the occurrence of involuntary resettlement for land expropriation necessary for construction of intake facilities and water treatment equipment, pipelines for drinking water, elevated water tanks and public taps

- Land utilization

: Response to effects on land required for utilization

- Protected area/cultural heritage

: Response to effects when protected area/ cultural heritage exist

- Atmospheric pollution/noise and vibration/ others

: Response to effects of atmospheric pollution/ noise and vibration/ wastewater from backwashing and filter membrane chemical washing

The legal system for environmental and social considerations in Myanmar is still in the development stage. The Environmental Protection Act which forms the basis does not include descriptions related to environmental impact assessment. The legal system related to environmental impact assessment (EIA) is being prepared by the Ministry of Environment Conservation and Forestry (MOECF). It is preferable to use the JICA Guidelines for Environmental and Social Considerations (April 2010) until the legal system related to EIA comes into force.

5.2 Patheingyi City

5.2.1 Institutional adequacy and sustainability when major alternatives and the projects are implemented

1) Major alternatives

Patheingyi City does not have a modern water supply system, and no organization exclusively responsible for water supply facilities exists in the Patheingyi Township Development Committee. In view of the above, it does not have any alternative plan for supply of drinking water as a quick solution in the area being studied. However, it is adequately aware of the necessity of ensuring safe drinking water, and has shown keen interest in realizing the Project.

2) Institutional adequacy and sustainability when the project is implemented

No organization responsible exclusively responsible for water supply facilities exists in the Patheingyi Township Development Committee.

Not only the mobile water purifier but also the piped water supply system is to be introduced for the first time. The O&M of the mobile water purifier system is comparatively simple. Employees may be endowed with operating and managing skills by handing-over training and

by improving the operation and management support system during the operating period (maintenance and inspection by the supplier entrusted by the owner, etc.). It is also effective to introduce water supply management conforming to international standard under Management Contract with international water operator, bearing in mind the operation and maintenance of the forthcoming piped water supply system.

Management Contracts are widely used as the most basic form of PPP in the water supply business in developing countries. The public Water Supply Board constructs and owns water supply facilities. Private water supply operator (company) operates, maintains and manages the facilities for a specific period (for instance 5 years) jointly with the Water Supply Board, and receives management fees for the same. The private water supply operator does not bear tariff risk.

Management Contract scheme is suitable for developing countries where private water supply operators cannot help having reservations in PPP participation because of the lack of the regulatory framework necessary for establishing full-fledged PPP schemes such as Concession scheme, Lease scheme or BOT scheme and tariff risk is high.

Management Contract of Ghana Water Company Limited (GWCL) (example of Management Contract)

The World Bank gave a loan of 103 million dollars for the Urban Water Project through the Government of Ghana to the Ghana Water Company Limited, which was responsible for water supply to urban areas in the whole of Ghana in July 2004, as funds for provision of water supply facilities. The condition for the loan at that time was that GWCL had to conclude a Management Contract with a private company. Initially, the Government of Ghana aimed to introduce PPP through the Lease scheme, but since the private operator would have to bear the water tariff risk in the Lease scheme, no private operator could be found to take the job. Therefore, PPP introduction by the Management Contract scheme was accepted under advice from the World Bank.

GWCL concluded a five-year Management Contract in 2006 with Aqua Vitens Rand Ltd. (AVRL) which was the joint venture company established in Ghana between Aqua Vitten of Holland and the Rand Water Board of South Africa. The conceptual sketch is shown below.

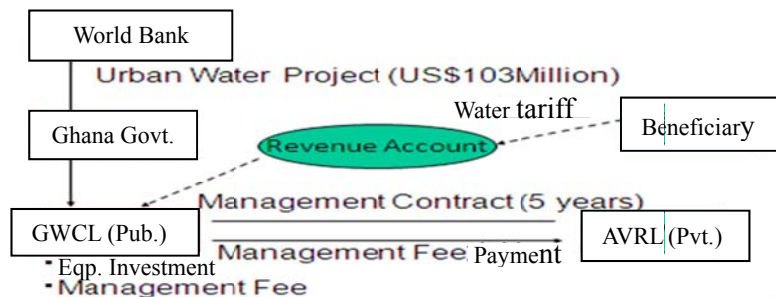


Fig. Conceptual sketch of Management Contract for urban water supply in Ghana

- ① AVRL (private operator) is responsible for managing the entire water supply works from the water treatment plant to the distribution network.
- ② The responsibility for new equipment investment lies with GWCL and the Govt. of Ghana through World Bank loan. AVRL is responsible only for the operation and maintenance of existing and new equipment. AVRL has no financial risk since it is not responsible for the financial resource mobilization for investing in equipment.
- ③ AVRL is responsible for the operation of the entire water supply works including tariff collection. But the water tariff collected by AVRL is handed over to GWCL, while AVRL only receives the management fees. Consequently, AVRL does not bear the tariff risk, in principle.
- ④ The management fees paid by GWCL to AVRL is principally cost-based (man-month based). Bonus or penalty will be added or deducted depending on the performance. For instance, if the amount of chemicals used decreases because of the hard work put in by the private operator, bonus will be paid. On the fifth year if non-revenue water (NRW) ratio does not decrease as estimated, penalty will be imposed on the private operator.
- ⑤ Management fees paid by GWCL to AVRL will be covered by of the World Bank loan (in practice, the loan has become the grant, as the result of HIPCS).

After the entry of AVRL, GWCL improved the balance of profit and loss resulting in a surplus; however, it failed to improve the non-revenue water ratio (NRW), which remained at the high level of 50% as in the past. The closing date of the Management Contract between GWCL and AVRL arrived in May 2011, and the contract was not renewed probably because the assessment was severe on account of the unsatisfactory NRW result.

In case of Pathein, the contract with the international water operator will be concluded in two stages.

- Water Supply Board establishment stage (2015-2017)

Advisory Contract and Management Contract (international water operator to conclude contract directly with Pathein City Water Supply Board)

Description of the management advisory services provided by the international water operator and their cost	Organization of Water Supply Board (Myanmar side is responsible for establishing this organization)
<p>1. Business: Coordination with consultant responsible for provision of water supply facilities, guidance for operating mobile water purifier</p> <p>2. Dispatch of experts: Administration, regulation and finance, planning and execution management, measures for customers (including house connection)</p> <p>Man-Month: Total 20M/M Total 500,000 dollars</p> <p>3. Training the staff of the Water Supply Board</p> <ul style="list-style-type: none"> • Training in Japan (using JICA training course) • Dispatch to either Vietnam or Thai Training Center 	<p>Head Office (3 persons): Executive Director -1, secretary- 1, General Affairs and Personnel - 1</p> <p>Mobile Water Purifier Department: Staff operating mobile water purifier – 12; tariff collection staff: 5</p> <p>Piped Water Supply Department: Planning Section - 2, Finance Section – 1; Customer-related: 2</p> <p>Total: 25 persons (2015)</p>

- O&M Start Stage for the piped water supply system(2018-2022)

Management Contract (the joint venture company established by international water operator together with Myanmar company to conclude contract with Pathein Water Supply Board)

Description of the services provided by the international water operator in the Management Contract and their cost	Responsibilities of the Myanmar side (Water Supply Board)
<p>1. Establish the joint venture company Myanmar Water Supply Service (MWSS) (2018)</p> <p>2. MWSS to conclude Management Contract for a period of 5 years with the Water Supply Board (2018-2022)</p> <p>3. Staffs dispatched by international water operator to MWSS</p> <p>Administration, regulation and finance: 3 MM</p> <p>Water quality control: 3 MM</p> <p>Water treatment: 3 MM</p>	<p>1. Strengthening the organization of the Water Supply Board</p> <p>Head Office: Executive Director -1, secretary – 1, General Affairs and Personnel – 13</p> <p>Purification Dept.: 31 (Engineers – 7, technicians - 21, office boys – 3)</p> <p>Distribution Dept.: 28 (Finance and customer sections – 5, meter section – 10, tariff collection section - 5, maintenance section - 5, securing and store sections - 3)</p>

<p>Distribution management: 4 MM Machinery maintenance: 3 MM Customer measures (including promoting house connection): 3 MM Others: 1 MM Total: 20 MM (500,000 dollars)</p> <p>4. Training the staff of Water Supply Board</p> <p>Training in Japan (using JICA training program)</p> <p>Dispatch to either Vietnam or Thai Training Center</p>	<p>(Above to be in place by 2019)</p> <p>2. Provision of water supply facilities</p> <p>Construction of the piped water supply system (Phase-1): Completed by 2019</p> <p>Preparatory work for starting the piped water supply service: Starts from 2018</p>
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Concept of Management Contract for Pathein City (draft) (referring to Ghana Management Contract)

- Water supply facilities will be constructed by the public sector utilizing donor assistance or government budget. Private operator is not responsible for the development of facilities or fund mobilization for that purpose.
- Private operator will manage the Water Supply Board for a fixed period (for instance, five years)
- The staff of the Water Supply Board (except those in the Executive Director's Office) will be transferred temporarily to the private operator (company) but their salaries will be paid by the Water Supply Board. The salary amount of each staff member will be proposed by the private operator (company) and approved by the executives management of the Water Supply Board.
- Parts and materials necessary for operation of water supply facilities will be provided by the public sector to the private operator (company).
- The private operator (company) will collect water tariff on behalf of the Water Supply Board, but will hand over the collected water tariff to the Water Supply Board. The private operator (company) will not bear the tariff risk.
- Management fees will be paid in foreign currency by the government or the Water Supply Board to the private operator (company). In principle, management fees will be paid on the remunerations incurred (man-month basis). Around the fifth year of the management contract, bonus or penalty (reduction in fees) will be paid according to the performance of the Water Supply Board. These details will be specified in the Management Contract.

5.2.2 Financial conditions when the project is implemented

1) Capital expenses

For this Project, preliminary estimate of equipment investment is about 33,000 million Kyats, inclusive of the cost of the piped water supply system, the cost for introducing mobile water purifiers, and the cost of Management Contract with international water operator. For the consideration of funding of this projects, improvement on the tariff system, increased subsidies for equipment investment, and utilization of ODA (grant aid, loans with low interest, etc.) are necessary.

2) Operation and maintenance cost

The direct operation and maintenance cost of the piped water supply system is estimated as approximately 92 Kyats/m³, and the depreciation cost is estimated as approximately 200 Kyats/m³.

The operation and maintenance cost for mobile water purifier is approximately 2,000 Kyats/m³ (40 Kyats/20L).

When water tariff for the piped water supply is set at the level recoverable of both operation & maintenance cost and capital cost, that is 350 kyats/m³ (US\$ 0.35), and the water tariff for mobile water purifier is set at the level recoverable of operation & maintenance cost, that is 2,000 Kyats/m³ (US\$ 2.0), the quantity of safe water (drinking water and domestic water) that can be purchased per day at 3% (1,200 Kyats/month = 40 Kyats/day) of the average income per person (Kyat 40,000/month) in Patheingyi City, and the preliminary estimated annual revenue from tariff of the Water Supply Board, are as shown in Table 5.1

Table 5.1 Preliminary estimated annual revenue from tariff of the Patheingyi City Water Supply Board

	Presently (No water supply)	2014-2018 (Mobile water purifier)	2019 (Piped water supply system))	2024 (Piped water supply system))
Served population	0	0	70,000	140,000
Cost of safe water (Kyats per 20L)	300	40	7	7
Cost of safe water (Kyats/m ³ (US\$))	15,000 (15.00)	2,000 (2.00)	350 (0.35)	350 (0.35)
Quantity of safe water that can be purchased per day at 3% of the average income per person in Patheingyi City	2.7 L/day	20 L/day	114 L/day	114 L/day
Annual revenue from tariff of the Water Supply Board	0	66 Million Kyats	764 Million Kyats	1,529 Million Kyats

Source: Ministry of Health, Labor and Welfare, Study Team

3) Beneficial effects of Management Contract with international water operator

The effect of increase in revenue when the non-revenue water ratio is restricted to a low value is the most visible effect that appears as a result of concluding the Management Contract with international water operator. If the non-revenue water ratio for water supply system provided in Patheingyi City is lowered by 10% compared to when no Management Contract is concluded, the effect for ten years will be of the order of 1,500 million Kyats (150 million yen). Accordingly, even if the management fee paid is 100 million yen, it will be compensated by the effect as mentioned above.

The Yokohama Waterworks Bureau, which is the parent body of the Yokohama Water Company, is supporting non-revenue water measures of Vietnam's Hue City Waterworks Company under JICA technical cooperation, and has contributed to reducing the non-revenue water ratio by 10%.

5.2.3 Technical validity and sustainability when the project is implemented

The water source for the piped water supply system in Patheingyi City is the intake from the Patheingyi River at the north end of Patheingyi City. A water treatment plant with rapid sand filtering system is proposed to be constructed at the same point, and no technical issues in particular exist. Japan has an extensive track record of membrane filtration, one of the technologies used in the mobile water purifier, which is to be introduced as a interim water supply measure until the piped water supply system is completed. The water treatment process should be simple, water treatment should have high reliability even if fluctuations exist in raw water quality, equipment should be capable of automatic operation, O&M should be simple, and reliability should be high. Membrane filtration technology meets all these requirements.

Although the required water quantity is ensured throughout the year from Royal Lake and Patheingyi River, power outages occur daily in the Project area. Therefore, mobile water purifiers equipped with power generating functions are required. For this project, mobile water purifiers that satisfy these requirements must be introduced.

5.2.4 Environmental considerations

Environmental impact as mentioned below may be envisaged for this project. Response to the effects of the impact will be taken during project implementation.

- Water resource utilization : Response to effects on users of other applications of Royal Lake and Patheingyi River
- Land expropriation and involuntary resettlement
 - : Response to avoid the occurrence of involuntary resettlement for land expropriation necessary for construction of intake facilities and water

treatment equipment, pipelines for drinking water, elevated water tanks and public taps

- Land utilization : Response to effects on land required for utilization

- Protected area/ cultural heritage

: Response to effects when protected area/ cultural heritage exist

- Atmospheric pollution/noise and vibration/ others

: Response to effects of atmospheric pollution/ noise and vibration/ wastewater from backwashing and filter membrane chemical washing

The legal system for environmental and social considerations in Myanmar is still in the development stage. The Environmental Protection Act which forms the basis does not include descriptions related to environmental impact assessment. The legal system related to environmental impact assessment (EIA) is being prepared by the Ministry of Environment, Conservation and Forestry (MOECF). It is preferable to use the JICA Guidelines for Environmental and Social Considerations (April 2010) until the legal system related to EIA comes into force.

6. General remarks

6.1 Yangon

The target of this project are findings and formation of a water supply project in the areas where water supply is inadequate even if the plans progress in line with the JICA Master Plan 2013. The site study was conducted with the cooperation of YCDC, by accompanying the counterpart and selecting the study area while confirming the wishes of YCDC. The Summary of the project obtained through studies taking into account of YCDC's intention after the explanation and consultation related to the site survey and the mobile water purifier is shown as below.

- Objectives: To supply safe drinking water until full-fledged water supply system is provided
- Service area: Four areas of Dala TS 23 Villages, Seikgyikhanaungto TS, Kyauktan T/S and Thongwa, T/S
- Scale of plan: Supply scale Residents – 134,000 persons/ drinking water supply scale – 268 m³/d (equivalent units 2 L/person.day)
- Technology to be introduced: Mobile water purifier
- Provision of facilities:
- 1) Stationary water purifier 120 m³/d x 1 unit
 - 2) Mobile water purifier 200 m³/d x 10 units
 - 3) Pipelines for drinking water Dia. 75 x 3,000 m (10 m³ elevated water tank supply pipeline)
 - 4) 10 m³ elevated water tank x height 6 m x 1 unit (for stationary water purifier)
 - 5) 5 m³ elevated water tank x height 3 m x 1 unit
- Initial investment: About 700 million yen (7000 million Kyats taking foreign exchange rate as 1 yen=10 Kyats)
- Implementation scheme: PPP (assuming YCDC, local company and Japanese company)

The main focus of the study this time was project findings and formation; study for proceeding to the next stage was not included. Before the project implementation, items below must be studied and profitability of the project should be examined. Through such process, it must be measured whether the project would succeed or not.

- Existence of subsidies for initial investment (elimination of viability gap)
- Interest level of public or private loan

- Understanding preferential custom duties for import of materials and equipment
- Price settings that will ensure that business is not in the red
- Number of years for recovery of capital cost (preliminary estimate: taking residual value as 10%, service life of equipment as 16 years)
- Checking the will of the people to purchase drinking water at the set price and setting the scale of the business
- Studying the possibility of forming a cooperative system with local water vendors (stakeholders)

It is preferable for project implementation to proceed sequentially from areas with good profitability (1 year for provision in 1 area), preferably with project duration making maximum use (about 16 years: refer to Local Autonomy Act) of service life from the aspects of reducing the capital cost. Together with profitability study, project implementation priority and the years in business must be studied.

It is preferable that a feasibility study will be carried out to move to the next step.

6.2 Pathein City

The objectives are the findings and formation of the Project for supply of safe drinking water to Pathein City where water supply is insufficient. The site investigation was conducted accompanying the counterpart with the cooperation of the Ayeyarawady Regional Government that controls Pathein City. Plans for the proposed project were studied bearing in mind the wishes of the Ayeyarawady Regional Government. .

Objectives: To set up the Water Supply Board and start providing water supply. To supply safe drinking water using mobile water purifiers until the piped water supply system is developed. To strengthen the management skills of the Water Supply Board through the Management Contract with international water operator.

Service area: Whole of Pathein City, Ayerawady Region

Scale of plan: (Provision of the piped water supply) Supply scale Residents – 125,000 persons/ drinking water supply scale – 18,000 m³/d (equivalent units 114 L/person.day)

(mobile water purifier) Supply scale Residents – 4,500 persons/ drinking water supply scale – 90 m³/d (equivalent units 20 L/person.day)

Technology to be introduced: (Provision of water supply) Rapid sand filtration, (mobile water supply vehicle) mobile water purifier

Provision of facilities: 1) Water supply system 18,000 m³/d

2) Mobile water purifier 200 m³/d × 3 units

Initial investment: About 3300 million yen (33,000 million Kyats taking foreign exchange rate as 1 yen=10 Kyats)

Including 190 million yen (1900 million Kyats) for mobile water purifiers

Implementation scheme: PPP (Joint management of facilities constructed by Patheingyi City Water Supply Board with international water operator by Management Contract)

Since preparatory study for concrete cooperation for actually implementing the project is not included in this study, separate preparatory study for assistance is necessary to verify feasibility of implementing the entire project.

Document 1: list of interviewers

Yangon

Name	Rank	Department
U Hla Myint	Mayor	Yangon City Development Committee
Soe Si	Committee Member	Yangon City Development Committee
Myint Oo	Head of Department (Water & Sanitation)	Yangon City Development Committee
Daw Khin Aya Myint	Executive Engineer	Yangon City Development Committee
Htin Lin Kha	Executive Engineer	Yangon City Development Committee
Aung Ko Ko Tin	Sub Assistant Engineer	Yangon City Development Committee
Masaru Matsuoka	Water Supply Management Advisor	

Patheingyi

Name	Rank	Department
U Thein Aung	Chief Minister	Ayarwady Region Government
U Hla Khomy	Minister of Planning	Ayarwady Region Government
U Kyaw Win Naing	Minister of development Affairs	Ayarwady Region Government
U Aung Min Naing	Director	Department of Development Affaires, Ayarwady Region Government
U San Paw	Deputy Director	Water Resource Hydrology Department, Ayarwady Region Government
Dr. Ag Kyi Gwi	Regional Health Director	Ayarwady Region Government
U Than Kyaw Kyaw	Assistant Director	Ayarwady Region Government
U Thet Aung	Assistant Director	Town Development Committee
U Myo Kyi	Assistant Engineer	Town Development Committee
U Ye Win Aung	Assistant Engineer	Town Development Committee

Ministry of National Planning and Economic Department

Name	Rank	Department
U Tun Tun Naing	Director General	Foreign Economic Relations Department
Aung Moe Chai	Director	Bilateral Economic Cooperation Division
Wah Wah Maung	Deputy Director General	Foreign Economic Relations Department
Tsutomu Kudo	Adviser for Aid Coordination	

Japanese Embassy

Name	Rank	Department
Hideaki MATSUO	Counsellor (Economic & ODA)	
Go NAKAYA	Second Secretary	

JICA

Name	Rank	Department
Noriko Sakurai	Project Formulation Adviser	Water Resource, Disaster Prevention and Environmental Sector