Thailand

The Fourth Bangkok Water Supply Improvement Project (Phase 1)

Project Summary

Borrower:	Metropolitan Waterworks Authority（MWA） (Guarantor: Kingdom of Thailand)
Executing Agency:	Metropolitan Waterworks Authority（MWA）
Exchange of Notes:	September 1991
Date of Loan Agreement:	September 1991
Final Disbursement Date:	January 1998
Loan Amount:	¥8,638 million
Loan Disbursement Amount:	¥5,849 million
Procurement Conditions:	General Untied
Loan Conditions:	Interest rate: 3.0%, Repayment period: 25 years (7 years for grace period)

《Reference》

(1) Currency: Baht

(2) Exchange Rate: IFS average market rate

FY		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Rate	Baht/US$	25.702	25.585	25.517	25.400	25.320	25.150	24.915	25.343	31.364	41.359
	Yen/US$	138.0	144.8	134.7	126.7	111.2	102.2	94.1	108.8	121.0	130.9
	Baht/Yen	0.1863	0.1767	0.1894	0.2006	0.2277	0.2461	0.2649	0.2330	0.2592	0.3160
CPI		94.4	100	105.7	110.0	113.7	119.5	126.4	133.8	141.3	152.7

(3) Rate at the time of appraisal: 1 Baht = ¥5.3 (US$ 1.00 = ¥134 = Baht 25.1)

(4) Fiscal Year: October 1 to September 30

(5) Abbreviation

MWA: Metropolitan Waterworks Authority

(6) Terminology

① Classification of water conveyance, water distribution, and water supply

Water conveyance indicates the transport of clean water produced at water treatment plants to water distribution facilities that are relay points. The facilities employed for this purpose (pumps, etc.) are called water conveyance facilities, and the water pipes used to convey the water are called service pipe lines.

Water distribution refers to the distribution of water from relay points to end-users. The facilities employed for this purpose are called water distribution facilities, and the water pipes used to convey the water are called distributing pipes. The water pipes that link distributing pipes to water faucets are called water supply pipes, and water supply pipes and water faucets are collectively referred as water-service installations. Normally, water-service installations are owned by the end-user.

② Charged ratio, non-changed ratio (for details, see Water Consumption Breakdown on the next page.)

Non-charged ratio: The ratio (%) of water consumption that is not charged

Non-charged ratio = (Valid non-charged water amount + invalid water amount) ÷ Water consumption x 100

Charged ratio: The ratio (%) of water consumption that is charged

Charged ratio = Charged water amount ÷ water consumption x 100 or
Charged ratio = 100 - non-charged ratio

Water loss ratio: The ratio (%) of water loss against the water consumption

Water Consumption Breakdown

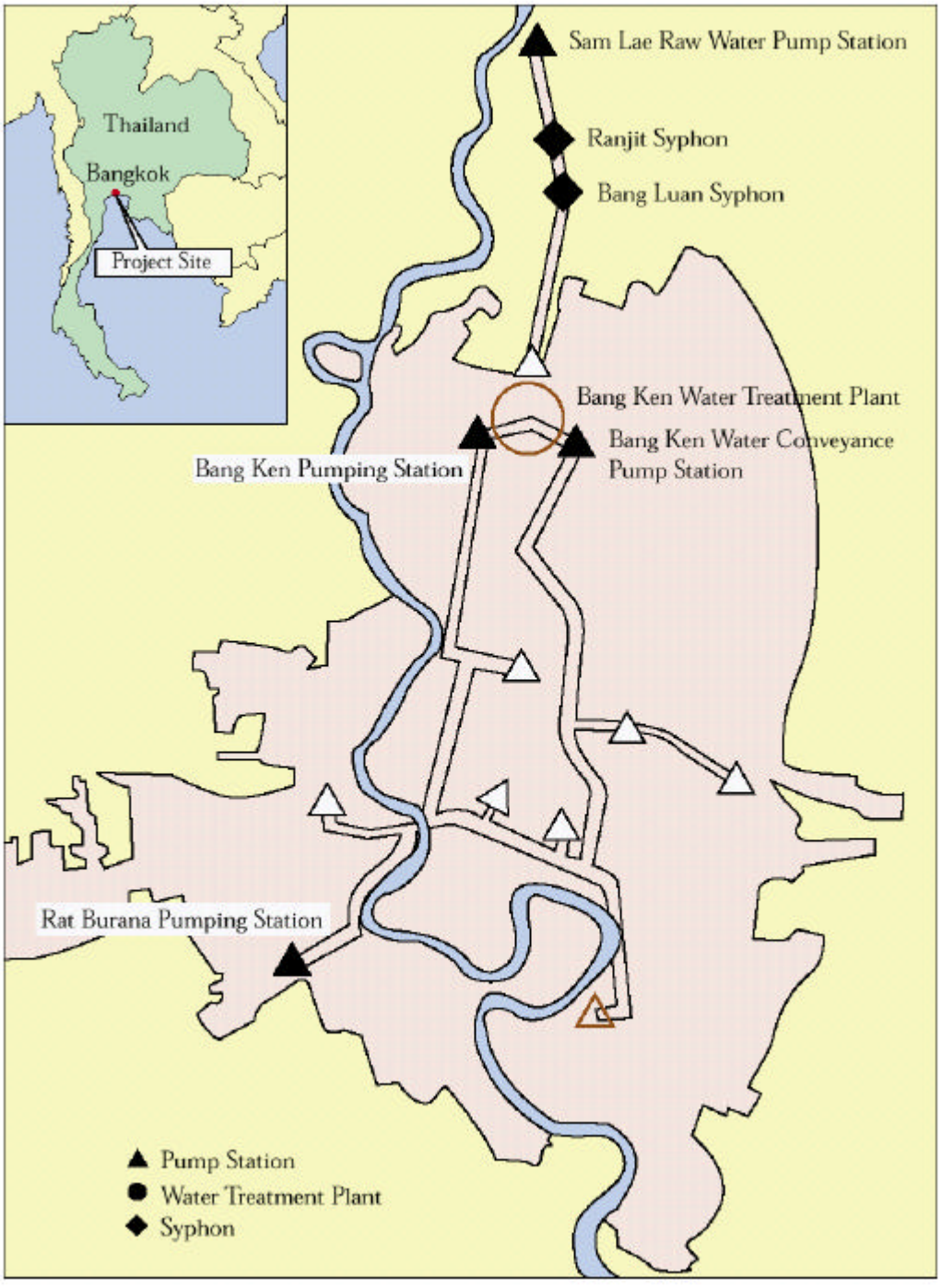
Water consumption	Available water	Charged water	Paid water	(1) Water amount serving as basis for collection (2) Fixed rate faucets and allowed water amount
			Diverted water	Water diverted to other channels
			Others	Water used for public purposes including parks and fire fighting for which a charge is collected using a different account.
		Non-charged water	Non-metered water	Effectively used water that is not charged due to failed meter detection
			Water used by Water Department	Water used by Water Department for water distribution facilities, including pipe cleaning and water loss prevention
			Others	Water used for public purposes such as parks and fire fighting that is charged using a different account.
	Non-available water		Reduced charge water	Water discounted at time of collection, due to red water
			Water loss	(1) Water loss from distributing main pipes (2) Water loss from distributing sub pipes (3) Water loss from water supply pipe upstream from meter
			Others	Water that has become invalid due to other damage in water facilities and non-accounted-for water

③ Lift: The height through which a pump can raise water or other liquid.

1. Project Summary and Comparison of Original Plan and Actual

1.1 Project Location

Project Location Map for The Fourth Bangkok Water Supply Improvement Project Phase 1



1.2 Project Summary and ODA Loan Portion

The project subject to this ex-post evaluation, The Fourth Bangkok Water Supply Improvement Project Phase 1 (hereafter called "the Project") was a part of the Bangkok Metropolitan Water Supply Improvement Project Master Plan (hereafter called "1990 Revised Master Plan"), which was established in 1970 with completion targeted for 2000 and was revised twice in 1984 and 1990. This project aims to expand the capacity of the Bang Ken Water Treatment Plant (from 2,800,000 m^3/day to 3,200,000 m^3/day), which supplies water from the Chao Phraya River and expand the distributing pipe network, so as to improve water service conditions in the Bangkok metropolitan area. (For the positioning of the improvement project within the master plan, see sections 1.3.2.)

Of the total project cost of ¥17.143 billion, ODA loan covers the entire foreign currency amount of ¥8.638 billion.

1.3 Background

1.3.1 National Economic and Social Development Plan and Waterworks Sector

Since the establishment of the 1st National Economic and Social Development Plan in 1961, the Thai economy has achieved an annual growth rate of nearly 7%, but the growth rate declined slightly to 5.4% during the 5th Plan (1982 to 1986).

Under this economic circumstances, the 6th Plan (FY 1987~1991) emphasized the importance of infrastructure improvements to stimulate the economy, raise the national income and create jobs. As for social infrastructure, expansion of infrastructure and improvements in services in line with the growth of municipalities were deemed to be important.

In the water sector, the targets were to expand facilities and reduce water loss from existing facilities in order to increase the volume of daily water supply by 1,557,000m^3 (500,000m^3 in the Bangkok metropolitan area and 1,057,000m^3 in other regions) within the five years of the 6th Plan.

1.3.2 Positioning of Improvement Project under 1990 Revised Master Plan

The long-term plan (Master Plan) for the improvement of water supply in the Bangkok metropolitan area was first established in 1970 with the participation of U.S. consultants in order to fulfill water requirements up to the year 2000. After that, the Master Plan was reviewed in 1984 and 1990. MWA has improved water supply infrastructure as follows, based on the 1990 revision of the Master Plan: ① Expansion of water treatment plant to grow water treatment capacity, ② Installation of service and distributing pipe lines to broaden the water supply area, and ③ Rehabilitation of service and distributing pipe lines to reduce water loss. In February 1991, when the appraisal for this stage was conducted, Stage I to III had already been completed, and the additional project to Stage III and the emergency Bang Ken expansion

project were under way.

Table 1.1 Expansion Schedule of Bang Ken Water Treatment Plant Based on 1990 Revised Master Plan

	(Unit)	Stage 1	Stage 2	Stage 3	Emergency Bang Ken Expansion	Addition to Stage 3	Stage 4
Targeted year		1983	1985	1987	1991	1992	1996
Water treatment capacity (increased portion)	1,000 m^3/day	800 (800)	1,600 (800)	2,000 (400)	2,400 (400)	2,800 (400)	3,200 (400)
Loans from other organizaitons	$ 1 million	World Bank 55 ADB 19.6	ADB 68	ADB 131	—	—	—
ODA Loan	¥ 1 million		6th loan 8,400	11th loan 10,710 12th loan 9,546		14th loan 4,380	16th loan 8,638 (this project)

(Source: Materials at the time of appraisal)

1.3.3 Capacity of Waterworks Facilities in Bangkok Metropolitan Area and Water Supply Conditions

As of the end of December 1990, the Bangkok metropolitan area had three water treatment plants (Bang Ken: 2,000,000m^3/day, Samsen: 545,000m^3/day, and Thonburi: 173,000m^3/day), and 42 deep wells (37,000m^3/day) as underground water usage facilities. Combined, these facilities had a total water supply capacity of 2,755,000 m^3/day.

According to MWA documents at that time, the population of Bangkok was expected to grow rapidly from 7.814 million in 1990 to 9.06 million in 1996. Over the same period, daily water demand was expected to rise from 2.781 million m^3/day to 3.897 million m^3/day. In addition, land subsidence due to pumping of groundwater was becoming a grave social problem (see 1.3.4 below) and regulations were placed against the pumping of groundwater after 1987.

If the capacity of the facilities remained at the level of the end of December 1990 (2.755 million m^3/day) with no further investment in increasing water supply capacity, the supply shortfall would reach 55,000m^3/day by 1996. Therefore, it was necessary to expand the Bang Ken Water Treatment Plant and improve the water conveyance and distribution networks with the aim of meeting demand in 1996 and after.

In order to fill the gap between supply and demand from 1996 onward, it was deemed necessary to expand the capacity of the Bang Ken Water Treatment Plant by 400,000m^3/day under this project.

Table 1.2 Demand Projection and Facility Capacity Reinforcement Plan

(Unit: 1,000m^3/day)

Year	1990	1992	1994	1996	1997	1998	1999
Demand							
Average demand (A)	2,781	3,114	3,510	3,897	4,095	4,239	4,383
Maximum demand (B)	3,090	3,460	3,900	4,330	4,550	4,710	4,870
Supply capacity (*)							
Bang Ken	2,000	2,400	2,800	2,800	2,800	2,800	2,800
Samsen・Thonburi	718	718	873	873	873	873	873
Others(**)	37	139	169	169	169	169	169
Total (C)	2,755	3,257	3,842	3,842	3,842	3,842	3,842
Demand and supply gap							
(C)－(A)	-26	143	332	-55	-253	-397	-541
(C)－(B)	-335	-203	-58	-488	-708	-868	-1,028

(Source: MWA materials as of end of January 1991)

(*) Assuming the supply capacity in 1996 and later remained unchanged from the level of the end of December 1990, with absolutely no investment in expanding supply capacity. Above all, the water supply facility capacity is also assumed to be remained unchanged.

(**) Deep well, simplified water treatment system, water supply wagon.

1.3.4 Problem of Ground Subsidence Caused by Groundwater Pumping

The water supply area of MWA at the end of September 1989 (with water supply system and deep wells) was 625km^2, which was no more than 20% of the area it was responsible for. People in other areas where water was not supplied by MWA system used groundwater for everyday uses. Even within the water supply area, some of the water came from deep wells, as noted above. This method worsened the problem of ground subsidence due to excessive pumping of groundwater in the capital region.

In May 1983, the Thai government announced regulations against groundwater pumping and called for strict observance of the regulations. From 1987, restriction on groundwater pumping in the Bangkok capital region was phased in and the target was to reduce the total volume of groundwater pumping, including pumping by individuals, to 800,000m^3/day or less by 2000. In order to reach the target, MWA had to increase water supply capacity using surface water to substitute for groundwater usage. The expansion of water treatment plant and water conveyance and distribution networks were urgent tasks for that purpose.

1.3.5 History

1970		Completion of Bangkok Metropolitan Water Supply Improvement Project Master Plan
1975		Start of Stage I-Phase 1 construction (The World Bank and ADB loan).
1979	June	Provision of ODA loan for Stage I-Phase 2 (6th ODA loan ¥8.4 billion)
1984	February	Completion of 1984 Revised Master Plan for plans after Stage II.
1984	September	Provision of ODA loan for Stage II-Phase 1A of 1984 Revised Master Plan (11th ODA loan ¥10.710 billion)
1985	October	Provision of ODA loan for remaining amount for Stage II-Phase 1A (12th ODA loan ¥9.546 billion)
1988	November	Provision of ODA loan for Stage II-Phase IB (14th ODA loan ¥4.380 billion)
1990	October	Completion of 1990 Revised Master Plan
1990	November	Request of this project
1991	February	Dispatch of appraisal mission of this project
1991	July	Prior notification
1991	September	E/N conclusion of this project
1991	September	L/A signing of this project
1993	April	Signing of contract for Bang Ken Water Treatment Plant expansion work
1995	October	Start of water conveyance from Bang Ken Water Treatment Plant

1.4 Comparison of Original Plan and Actual

① Project Scope

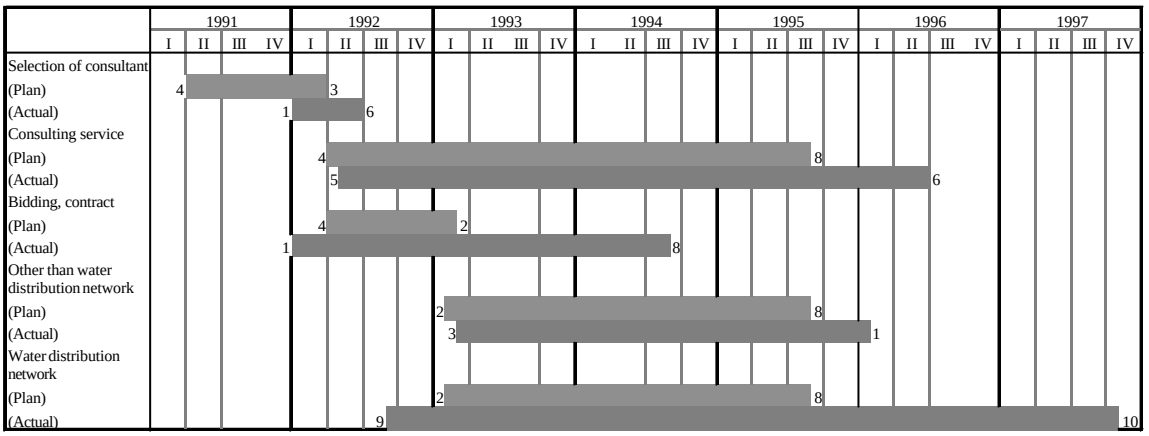
Project Scope	Plan	Actual	Difference
1. Expansion of siphon			
Bang Luan syphon	2.5m x 3.0m: 2	Same as left	—
Ranjit syphone	2.5m x 3.0m: 3	Same as left	—
2. Expansion of Bang Ken Water Treatment Plant			
High-speed collecting sedimentation basin	200,000 m^3/day x 2	Same as left	—
Lagooning	75,000 m^3/day x 4	Same as left	—
Sun-dried floor	75,000 m^3 x 4	Same as left	—
Chemicals injection facilities	One set	Same as left	—
Sludge discharging facilities	One set	Same as left	—
Receiving and transformer facilities	15,000KVA	Same as left	—
3. Reinforcement of pump station			
Sam Lae Raw Water Pump Station	720,000m^3/day, Pump head 3m	Same as left	—
Bankg Ken Conveyance Pump Station	432,000m^3/ day, Pump head 33m	Same as left	—
Bang Ken Distribution Pump Station	160,000m^3/ day, Pump head 50m	Same as left	—
Rat Burana Distribution Pump Station	160,000m^3/ day, Pump head 50m	Same as left	—
Sedimentation basin	20,000m^3		—
4. Improvement of water distribution network			
Distributing main pipe (φ600mm～1,500mm)	42.7km	44.0km	+1.3km
Distributing sub pipe (φ50mm～300mm)	400km	323.8km	-76.2km
Distributing sub pipe (rehabilitation) (φ50mm～300mm)	107km	109.2km	+2.2km
5. Consulting Service	Foreigners: 129M/M Local people: 110M/M	Foreigners: 78M/M Local people: 313M/M (In addition, 329M/M as assistant staff except engineers)	-51M/M +203M/M

(Sources: Materials at the time of appraisal, MWA materials)

② Implementation Schedule

	Plan	Actual	Difference
Selection of consultant	1991.04 - 1992.03 (12 months)	1992.01 - 1992.06 (6 months)	+3 months (−6 months)
Consulting Service	1992.04 - 1995.08 (41 months)	1992.05 - 1996.06 (50 months)	+10 months (+9 months)
Bidding, contract	1992.04 - 1993.02 (11 months)	1992.01 - 1994.08 (32 months)	+18 months (+21 months)
Civil works			
Other than water distribution network	1993.02 - 1995.08 (31 months)	1993.03 - 1996.01 (35 months)	+5 months (+4 months)
Water distribution network	1993.02 - 1995.08 (31 months)	1992.09 - 1997.10 (62 months)	+26 months (+31 months)

(Sources: Materials at the time of appraisal, MWA materias etc.)



③ Project Cost

Unit: ¥1 million

Item	Plan (at the time of appraisal)		Actual		Difference	
	Foreign currency	Local currency	Foreign currency	Local currency	Foreign currency	Local currency
(1) Expansion of syphon	331	111	287	105	-44	-6
(2) Expansion of water treatment plant	1,483	470	1,433	418	-50	-52
(3) Reinforcement of pump station	1,101	176	795	122	-306	-54
(4) Improvement of water distribution network	3,950	2,048	3,147	1,810	-803	-238
(5) Consulting service	354	77	181	143	-173	+66
(6) Price escalation	666	396	-	-	-666	-396
(7) Reserve cost	753	320	-	-	-753	-320
(8) Tax etc.	-	4,907	-	2,919	-	-1,988
Total	8,638	8,505	5,843	5,517	-2,795	-2,988

[Exchange Rate] At the time of appraisal (January 1991): 1 Baht = ¥5.3
At the time of completion (Average value at the time of loan disbursement): 1 Baht = ¥4.2

2. Analysis and Evaluation

2.1 Evaluation of Project Implementation

2.1.1 Project Scope

There were no major changes in the scope of the project. The length of distributing sub pipes was reduced by approximately 76km, but that change was made because installation of distributing sub pipes had to be carried out on an emergency basis in some areas using the MWA's own funds to meet demands from residents. Therefore, this installation was removed from the scope of the project. Although the removed portions are not included in the project scope and the cost described in 1.4, the project can be said to have been effectively completed as per the original scope as the removed portion were installed by MWA's own fund.

2.1.2 Implementation Schedule

There was a delay of approximately 31 months in the improvement of the water distribution network. The delay was due to the time taken for acquisition of a permit for water pipe laying from the Bangkok Metropolitan Authority (BMA), and the need to reroute some of the water pipes when the permit was refused for some areas[1].

The permit application to the BMA for laying distribution pipes was made after the detailed design had been prepared and the distribution pipe routes decided, but for some areas the permit was refused by the reason of extremely high road traffic volumes. Therefore the distribution pipe routes had to be altered and the detailed design reworked, causing a delay of 18 months in the stage of preparation for the tender for the distribution network improvement. Even for the areas where the BMA permit was granted, the deliberations had taken a long time, and in some areas the permit only allowed working at night out of consideration for traffic congestion. Completion of the network over the whole area was delayed by 31 months. As a result some areas were not completed within the initial loan disbursement deadline and the deadline had to be extended by one year.

There were some delays in portions other than the distribution network, but all work was complete by January 1996. The expansion of the Bang Ken Water Treatment Plant, which was the main portion of this project, was completed in September 1995 and the new facilities went into operation from October 1995.

2.1.3 Project Cost

Compared to the original plan, both the local and foreign currency portions of the project cost underran. The main cause for the cost underrun was the appreciation of the Yen during 1992 and

[1] When water distribution pipes are laid in the Bangkok metropolitan area, the works obstruct the flow of traffic. Therefore a road usage permit must be obtained from the Bangkok Metropolitan Authority.

1993, which coincided with the construction period[2]. Compared to the time of the appraisal, the Yen was stronger when the contract and loan were executed, which meant the Yen-based value of the project cost was lower than anticipated (The Baht-based project cost was almost as planned). In the item by item breakdown, the cost of all items was reduced, but the reduction was greatest in the water distribution network improvement and taxation.

As mentioned above, the cost of the water distribution network was reduced by two factors: ① MWA laid around 76km of the pipes with its own funds, and ② some portions did not receive permission from BMA and were altered.

As for taxation, there are some elements of taxation that cannot be isolated and identified separately from the main cost and therefore the recorded taxation cost has been reduced by the inclusion of some taxation within the main project cost.

2.1.4 Implementation Scheme

(1) Executing agency

MWA is the executing agency for this project. MWA was established in 1967 as a public corporation under the supervision of the Ministry of Interior, and it has been supplying water in the Bangkok metropolitan area since then. Its organization comprises six offices which employs 6,441workers (as of March 1999) and a department in charge of this project was the Project Management Department, which has a staff of 66.

The privatization of MWA is currently under consideration. The privatization is studied in the light of the streamlining of state-owned enterprises following the currency crisis of July 1997. The broad aims include clarification of MWA's authority over water supply and sewerage policy and promotion of free competition, but the details have yet to be settled. The current plan is that the Thai government will take part in the MWA management, as the largest shareholder, retaining a majority of share after privatization.

(2) Consultants

With regard to the consulting services, in response to the wish of the executing agency to continue receiving support for the implementation of this project from the consultants (joint venture among Japanese consultants and Thai consultants) who made the 1984 Revised Master Plan and did the detailed design of the Stage II Plan, an optional contract was signed. Therefore the time to select consultant was shortened by six months compared to the original plan.

The M/M breakdown saw a decrease in M/M for foreign consultants and an increase in those for local consultants. The change was due to the MWA's cost-cutting policy in which the work of foreign consultants is replaced as far as possible by cheaper Thai consultants. The increase in

[2] Even within the foreign currency portion, many of the contracts were actually Baht-based.

M/M for Thai consultants did not cause any deterioration in the quality of consulting and there did not appear to be any significant problem with consultant ability.

(3) Contractors

The civil works, equipment and materials required for this project were procured through 36 contracts. Of those, two fell behind the original schedule of the appraisal by 18 months. These contracts were for the procurement and installation of some of the water distribution pipes and water meters. The delay was due to external factors, mainly the measures taken to avoid causing traffic congestion, and was not caused by poor contractor performance. Although the improvement of the water distribution network delayed the completion of the project, there were no major problems in the operation of the equipment after the project completed, which indicates that there was no problem with the performance of the contractors.

The portions of the project other than the improvement of the water distribution network suffered no major delays of implementation schedule and there were no unusual problems in the subsequent operational performance, which indicates that there was no problem with the performance of the contractors.

2.2 Evaluation of Operations and Maintenance

2.2.1 Operations and Maintenance Scheme

(1) Operations and maintenance scheme

The following three departments of MWA are responsible for operation and maintenance of the facilities which were constructed by this project

Water intake plant ~ Bang Ken Water Treatment Plant:

Treatment Plant Service Department (No. of staff: 163)

Water distribution network:

East Bank Water Distribution Control Department (No. of staff: 129)

West Bank Water Distribution Control Department (No. of staff: 94)

(2) Fostering of technicians and specialists

In terms of human resources development, MWA aims to upgrade the skill level of its workers in each field at the National Waterworks Technology Training Institute (NWTTI), which was established and is managed with grant assistance from Japan and project-type technical cooperation of Japan.

Japanese project-type technical cooperation was implemented over two periods at NWTTI, in Phase I from 1987 to 1992, and Phase II from 1994 to 1998. In Phase I, 809 MWA employees took training courses of five fields, (1) water supply management, (2) water supply planning, (3) water treatment and water quality control, (4) machinery and electric equipment installation,

and (5) maintenance of conveyance and distribution network. In Phase II, 28 specialty courses were established and a total of 252 MWA employees received training as of the end of September 1997 for the purpose of further improvement of waterworks technology.

2.2.2 Operations and Maintenance

(1) Clean water supply quantity

The additional 400,000m^3/day capacity of the Bang Ken Water Treatment Plant, which was added by this project, went into operation in October 1995, at the start of FY 1996. Table 2-1 shows the clean water capacity and actual supply record in Bank Ken Water Treatment Plant as of each end of fiscal year. As can be seen in this table, the Bang Ken Water Treatment Plant continuously maintains approximately 90% of its clean water supply capacity, which is considered to be very acceptable.

Table 2.1 Actual Record of Clean Water Supply in Bang Ken Water Treatment Plant

(Unit: 1,000m^3/day)

FY	1991	1992	1993	1994	1995	1996	1997	1998
Actual record of clean water supply in Bang Ken Water Treatment Plant	2,103	2,243	2,388	2,441	2,825	3,020	3,048	3,107
Clean water capacity in Bang Ken Water Treatment Plant	2,000	2,400	2,800	2,800	2,800	3,200	3,200	3,200
Water supply ratio (actual record/capacity) (%)	105.2	93.5	85.3	87.2	100.9	94.4	95.2	97.1

(Source: 1997 MWA Annual Report etc.)

(Note) In FY 1991 and FY 1995, actual supply record exceeded treatment capacity. Since it was made possible by designing the capacity of equipment in the plant taking some degree of the safety factor into consideration in clean water supply volume had been within the capacity thereafter.

(2) Water quality

As to control of water quality, MWA manages water quality at four stages in the process of clean water distribution[3], namely at the water source (the Chao Phraya River), the water treatment plant, in conveyance and distribution, and at the faucet in the home. The water quality of the Chao Phraya River at the Sam Lae raw water pump station (the water source stage) has been slightly deteriorating compared with four years ago, but within the range that will not invoke problems. The Thai drinking water standard follows WHO standards[4]. As far as it can be seen from the figures obtained through this evaluation, the quality of clean water treated by

[3] Sampling and testing at the water source, water treatment plant and distribution pumps are under the jurisdiction of MWA, but the Ministry of Public Health handles sampling and testing from the faucet in users' homes, with the cooperation of Mahidon University.

[4] WHO Guideline 1993 for Drinking Water Standard.

MWA (actually the water quality tested at the faucet in users' homes) was within the allowable Thai drinking water standard values (maximum values). Therefore there is no apparent problem with water quality[5].

Table 2.2 Water Quality

FY	1993 April	1998 average value	1998 average value	1998 average value	Water quality standard value of Thai drinking water
Item \ Name of facility	Sam Lae Water Intake Plant		Bang Ken Water Treatment Plant	Faucet in the home (Skumbit district)	(Max. value)
Color (Pt-Co)	10	18	8	14	15
Turbidity (NTU)	57	79	1.19	1.69	20
pH	7.49	7.32	7.26	7.15	6.5～9.2
Hardness (mg/l)	92	89	103	90	- [6]
Magnesium (mg/l)	-	6.32	8.1	6.4	150
Calcium (mg/l)	-	25.0	27.7	25.3	200
Total Solids (mg/l)	250	256	177	157	1500
Oxygen Consume (mg/l)	4	4.47	-	-	-
Nitrate and Nitrite (mg/l)	0.19	0.34	0.31	0.38	10
Iron (mg/l)	0.67	1.00	0.02	0.05	1.0
Fluorine (mg/l)	0.24	0.29	0.4	0.26	1.0
Manganese (mg/l)	0.06	0.10	0.01	0.01	0.5
Numbers of coliform bacilli[7]	480,000	55,833	0	0	-

(Source: MWA)

(3) Charged ratio and water loss

Table 2.3 below shows the charged ratio and water loss ratio trends for the entire water supply area under MWA's responsibility over the past 8 years.

Table 2.3 Changes in the Charged Ratio and Non-charged Ratio

FY	1991	1992	1993	1994	1995	1996	1997	1998
Clean water volume (Mil. m^3)	1,109.2	1,175.5	1,224.9	1,234.3	1,405.2	1,549.4	1,632.8	1,554.9
Water supply volume (Mil. m^3)	781.3	823.4	836.1	816.1	870.3	911.2	944.7	916.2
Charged ratio (%)	70.44	70.05	68.26	66.12	61.93	58.81	57.86	58.92
Non-charged ratio (%)	29.56	29.95	31.74	33.88	38.07	41.19	42.14	41.20
Water loss ratio (%)	23.3	23.71	25.82	23.62	28.79	32.45	34.10	33.20

(Source: MWA Annual Report etc.)

Note: Water loss ratio is ratio against water supply volume.

[5] In 1997, MWA declared Bangkok's water to potable.

[6] Although there is no standard regarding hardness, reference values of calcium and magnesium have been established. Normally, hardness is measured as the calcium and magnesium contents of water. Since the concentration of both ingredients falls within these reference values, no problem is thought to exist.

[7] Japan's water quality standards dictate that no coli bacteria is to be detected.

According to this data, the non-charged ratio and water loss ratio have been increasing since FY1992, but in FY 1994 following the completion of the Bangkok Water Supply Rehabilitation Project which was implemented by 14th ODA loan, the water loss ratio fell momentarily, and is believed to be the effect of the Rehabilitation Project. However, the rising trend resumed the following year and further measures for improving water loss ratio need to be taken.

The non-charged ratio breaks down into ① water loss, ② meter errors, ③ reading misses by meter inspectors, and ④ water theft. As is shown in Table 2.4, water loss accounts for approximately 80% of the non-charged ratio. MWA established Water Loss Reduction Department and started to take counter-measures. According to the survey, almost all water loss occurs at the joints that link water supply equipment (mainly common homes) and distributing pipes.

In order to improve this water loss problem, MWA is replacing water distributing pipes of up to 300mm diameter, which are severely dilapidated, including the couplings between the pipes and feed equipment. According to records for 1998, they spent 445 million Baht to replace a total length of 280km of pipes. In 1999 they went on to replace a further 435km of pipe at a cost of 620 million Baht. When they replace pipes, they use materials that are more resistant to water loss[8], and they are moving indoor water meters to reinstall them on the exteriors of users' homes as a measure against non-charged[9]. However, the total length of water distributing pipes of 300mm or less in the Bangkok metropolitan area is 15,715,741m (as of the end of 1997), which means that even though the replacement program to date has been executed as planned, the annual pace is only a gradual 3~4% of the metropolitan area's total network. If the whole of the currently-planned program is carried out, the non-charged ratio will improve to 30% by 2004, but further measures against non-charged will have to be devised to improve the efficiency of the water supply system in the Bangkok metropolitan area.

Part of the non-charged ratio is due to water theft, which the MWA combats by imposing flat rate fines on offenders and paying 50% of the fine as a reward to the person who reported the theft. MWA believes it can monitor all water theft this way.

(4) Readiness to Y2K

MWA established Y2K Committee in 1997 to prepare for Y2K compliance, and the committee is working towards that end. A budget of 13.58 million Baht has been allocated for Y2K solutions, and all related problems are scheduled to have been eliminated by June 1999. However, nearly all MWA facilities are managed through manual operations[10] and they do not

[8] Distributing pipes of 100~300mm are now made of asbestos, PVC, iron and other materials, while water supply pipes and hydrants are made of copper, PVC and polybutene. In future the use of PVC in water supply equipment will be stopped and only polybutene will be used for hydrants.

[9] By March 1999 80% of the hydrants installed in homes had been reinstalled, with 100% scheduled for reinstallation by 2001.

[10] Computer systems have been installed to control some of the pumps at the Bang Ken Water Treatment Plant.

appear to be vulnerable to any major Y2K-related problems.

2.2.3 Financial Status of the Executing Agency

In this evaluation we will examine three aspects of MWA's financial position, namely the level of its water charges, its long-term foreign currency borrowing and its cashflow.

(1) Level of water charges standard

The MWA's balance sheets for the period between 1989 and 1997 show that their surplus varies largely between terms, but they record a net profit every term. In FY 1997 their ordinary profit was up around 66% on the preceding year, largely due to increased profits generated by increased water charges (MWA Statements of Income: See Appendix 1).

MWA reviews the level of water charges in the Bangkok metropolitan area every year. Its board of directors holds final authority over its charges, with the charges decided being communicated to the Thai Ministry of Interior and cabinet afterwards[11]. MWA must cover all expenses, including investment, from its water charges, but if the charges are too high, the rate of collection from consumers will decline[12]. Considering that balance, MWA considers that a price rise of 1.5 Baht every year would be appropriate[13]. The movements in water charges over the last six years (see Appendix 2) show that the rate was left unchanged between 1993 and 1996. That happened because, for political reasons, it was impossible to get permission from MWA board of directors for price rises, although MWA's financial department petitioned for increases every year.

MWA receives no subsidies from the government[14] and, according to the regulations set by the Thai Ministry of Finance, if they start any new business they must provide at least 25% of the total project cost from their own funds. Considering these conditions, the level of MWA's water charges cannot be described as unreasonable. Compared to other countries, the charges are not high (see Table 2.4).

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11 Most of MWA board of directors are directors of government agencies, including the Vice Permanent Secretary of the Thai Ministry of Interior.

12 No public meetings or hearings with consumers are conducted on matters such as the levels of water charges. The same is true of electricity and communications charges. Public hearings concerning public utility charges never happen in Thailand.

13 MWA studies have found that in order to cover finance repayments in the long term they will have to raise their charges by 14 Baht over the next seven years.

14 However, as the development of water sources has a high level of public interest and low profitability, government funding in the form of a governmental contribution (non-repayable) is invested and is recorded as capital on the MWA's balance sheets.

Table 2.4 Water Charges Standard in Major Asian Cities

Item \ Country	Kuala Lumpur	Manila	Bangkok	Seoul	Beijing	Dacca	Delhi	Jakarta
Average charges (US$/m^3) (A)	0.34	0.23	0.31	0.28	0.05	0.09	0.03	0.61
Per capita GDP in each country (B)	4,826	1,439	2,829	10,645	571	259	362	1,155
(A) / (B)×1000	0.07	0.16	0.11	0.03	0.09	0.35	0.08	0.53
Water supply diffusion rate (%)	100	67	82	100	100	42	86	27

(Source: ADB Second Water Utilities Data Book, Asian and Pacific Region, 1997)

(Note) Data is for 1995 ~ 1996.

(2) Long-term foreign currency borrowing

Foreign currency borrowing is converted at the average rate for each month, but in July 1997, the currency system was switched from the "Currency Basket" system[15] to a controlled float system[16]. This change also altered the method for calculating exchange rate conversion losses on long-term foreign currency borrowing.

Under the currency basket system, exchange rate conversion losses were deferred on the assets section of the balance sheet as "Deferred losses on foreign exchange rate" in order to distribute the cost over the term of the loan. When the Thai government announced devaluations of the Baht in 1981 and 1984, revaluation of the long-term foreign currency borrowing was made separately from the monthly revaluation, and the resulting revaluation loss was deferred in the capital section as "Deferred losses on Baht devaluation" to consolidate it over the term of the loan.

In July 1997, the losses incurred by the shift to the controlled float system were deferred to the capital section as "Deferred losses on managed float" in order to consolidate it as described above over the term of the borrowing. Thereafter, exchange revaluation losses occurred under the controlled float system, are accounted as expenses each month without deferment.

The deferred exchange losses[17] recorded on the balance sheet at the end of FY 1997 totaled 4.5 billion Baht. The profit and loss statement for FY 1998 shows that the income from water supply revenues was increased by 6.4% from the preceding year, but that was set off by the extreme increase in depreciation expenses on deferred exchange losses. The resulting ordinary profit, though still did not fall into the red, was decreased by 24.3% from preceding year. The cumulative exchange loss on long-term foreign exchange borrowing has a severe impact on MWA's ordinary profit.

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15 The national currency is linked to a weighted average of a number of currencies. In Thailand's case, the Dollar was given a high weighting, which meant the Baht was effectively linked to the Dollar.

16 A market system in which the government controls the exchange rate using finance policy.

17 On the balance sheet, these are deferred under the following three items: ① Deferred Losses on Foreign Exchange Rate, ② Deferred Losses on Baht Devaluation, ③ Deferred Losses on Managed Float

(3) Cash flow

MWA's forecast for its cash flow (C/F) for coming five years predicts a gradual decline in cash balance at the end of the each term, mainly due to the repayment[18] of borrowed indebtedness.

MWA aims to curb this trend with a number of measures, including increments of revenue by increasing water charges, improvement of the non-charged ratio, reduction of the collection period for water charge receivable and adjustment of the excess inventory. As Table 2.6 shows, the collection period for water charge is being reduced to some extent by the installation of numerous payment counters around the metropolitan area. However, after the economic stagnation in Thailand after the currency crisis in July 1997, the receivable turnover and collection period worsened in the public sector in FY 1998 and further efforts will be required to reduce the collection period.

Table 2.5 Collection Time of Trade Receivables

FY / Item	1996		1997		1998	
	Private	Public	Private	Public	Private	Public
Annual revenues/balance of receivables (times)	8.04	2.91	9.62	3.13	9.64	2.72
Collection time (actual result) (days)	46	126	38	117	38	134
Collection time (regulation) (days)	30	30	30	30	30	30

(Source: MWA Annual Report etc.)

In addition to long-term foreign exchange borrowing, MWA also obtains funds from the private sector through ① the issuance of MWA bonds and ② borrowing from private banks. Its financial statements for the last few years show that the volume of funds procured from the private sector is growing every year. MWA has also issued its bonds every year since 1994 and its reliance on funds from the private sector will go on rising, as shown in the cash flow forecast for the next five years. The table for the cash flow forecast is based on the assumption that the water supply charge will increase by 1.5 Baht every year. Based on that table, MWA is at risk of running short of cash in five years from now if they do not increase their procurement of funds from the private sector.

At present when MWA issues bonds they are 100% guaranteed by the Thai Ministry of Finance. Therefore their future bond issues will depend on the Ministry of Finance's policy on how to control MWA bonds.

Considering the above situation, JBIC, as MWA's largest creditor[19], must endeavor to keep close track of its cash flow and other financial situation.

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[18] MWA has agreed to swap contracts for its Yen-based debts to hedge its exchange risks between the Yen and Dollar. However, it took no particular hedging action against Baht-Dollar exchange risks and the repayment of long-term foreign exchange debts has been an even greater burden since the 1997 currency crisis.

[19] At the end of 1998 the outstanding balance of ODA loans amounted to 53.8% of the MWA's long-term debt.

2.2.4 Environmental impact

(1) The use of asbestos pipes

A majority of the water distributing pipes used in the Bangkok metropolitan area are made of asbestos (among 16,628km of supply and distributing pipes, 8,443km, 51% are made of asbestos, as of 1997). They are used because they are cheap and can be procured from domestic sources. However, they must be replaced with pipes of other materials in view of the environment, and also their inferior durability[20]. This point was indicated in the detailed evaluations for Bangkok Water Supply Rehabilitation Project etc. . According to Table 2.6, some new asbestos pipes are still being laid, but the share of all conveyance, distribution and supply pipes which are made of asbestos is gradually declining.

Table 2.6 Utility Trends of Asbestos Pipes

(Unit: km)

FY	1994	1995	1996	1997
Asbestos pipes	8,080	8,222	8,341	8,443
Total length of conveyance, distribution and supply pipes	15,057	15,514	16,069	16,628
Ratio (%)	53.7	53.0	51.9	50.8

(Source: 1997 MWA Annual Report)

2.3 Project Effects and Impacts

2.3.1 Quantitative Effects

At the time of the appraisal, the FIRR was put at 4.43%, based on the assumption that the project would bring an additional sales of 137.93 million m^3/year (comprising additional production of 102,930,000m^3/year from the expansion of the Bang Ken Water Treatment Plant and 35,000,000m^3/year from reduction of water loss through pipe rehabilitation). However, it was difficult to separate the operation and maintenance costs occurred purely from the facilities constructed under this project and the actual volume of water loss that would be reduced by this project. Therefore it is impossible to calculate actual and present FIRR in this evaluation.

2.3.2 Qualitative Effects

(1) Meeting increasing demand for water supply

The balance of supply and demand for water in Bangkok metropolitan area is as shown in Table 2.7. The project objective of meeting demand in 1996 has been achieved.

[20] Asbestos pipes are vulnerable to impact and have little shear strength. Bangkok has particularly weak soil and under such conditions asbestos pipes can easily lead to water loss, quite apart from their environmental problems.

Table 2.7 Demand Projection and Supply Results in the Bangkok Metropolitan Area

(Unit: 1,000m^3/day)

FY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Maximum demand (A)	3,160	3,350	3,540	3,700	3,720	4,240	4,660	4,920	4,690	4,720
Average demand (B)	2,870	3,040	3,220	3,360	3,380	3,850	4,230	4,470	4,260	4,290
Total supply amount (C)	2,875	3,039	3,221	3,356	3,382	3,850	4,245	4,473	4,261	4,550
Difference between demand and supply (C)-(B)	+5	-1	+1	-4	+2	0	+15	+3	+1	+260

(Source: MWA Annual Report etc.)

(Notes) Maximum demand: Demand projection by 1990 Master Plan.
Average demand: Demand projection by 1990 Master Plan.
Total supply amount: Total of groundwater and Bang Ken, Samsen, Thonburi, Maha Sawat Water Treatment Plants.
Figures until FY1998 are actual amount, and FY 1999 is planned figures.

As noted above, the water treatment plant expanded by this project began operation in October 1995. The monthly records of the water supplied by Bang Ken Water Treatment Plant show that the completion of this project contributed an increase to the volume of clean water supply.

Table 2.8 Monthly Actual Record of Clean Water Supply in Bang Ken Water Treatment Plant

(Unit: 1 million m^3/hour)

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
94	79.7	81.7	86.4	81.3	78.5	88.7	90.1	92.2	92.2	94.4	94.6	90.9
95	91.2	88.5	93.3	93.5	87.6	94.7	95.3	97.6	95.8	98.3	99.3	95.6
96	98.9	95.5	95.9	95.0	87.6	96.7	92.9	97.3	92.4	96.3	95.9	94.3
97	98.2	94.5	94.4	91.2	82.1	94.9	93.4	98.4	95.6	98.2	98.4	94.8

Note The treatment facilities of the Bang Ken Water Treatment Plant which were expanded under this project began operating in October 1995.

(2) Prevention of ground subsidence

In November 1995, the Thai Department of Mineral Resources conducted a survey of ground subsidence and found that the degree of ground subsidence in the metropolitan area was greatly improved to approximately half what it was in 1983, the year when the Thai government announced regulatory measures against ground subsidence.

However, as Table 2.11 shows, the volume of groundwater pumped up was increasing between 1990 and 1996. That increase was unavoidable due to the booming population in Bangkok after 1990 and the drought in 1994. From 1997, the volume of groundwater pumped began to decline, with a marked reduction in 1998 compared with the preceding year.

The pumping of groundwater is seen mainly in areas where the water distribution network has not been improved in the central system area. The completion of ODA loan project "Bangkok Water Distribution Network Improvement Project", (scheduled for completion in January 2001) now under way in Bangkok metropolitan area is expected to reduce groundwater pumping still further. The Thai government has prohibited groundwater pumping in principle since 1989. If groundwater pumping is required, a permit must be obtained from the government for the necessary volume of pumping.

Table 2.9 Movements in Groundwater Pumping in Bangkok Metropolitan Area

(Unit: 1,000m^3/day)

FY	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Central system	170.4	127.7	40.8	46.3	61.4	86.0	146.3	187.4	196.4	165.8	74.8
Separate system	25.8	30.4	32.6	41.9	44.7	34.2	45.5	51.0	55.3	48.5	34.5
Total	196.2	158.1	73.4	88.2	106.0	120.3	191.8	238.4	251.8	214.3	109.3

(Source: MWA Annual Report)
Central System: Water supply to most of Bangkok Metropolitan Area
Separate System: Water supply to towns on the outskirts of Bangkok[21]

(3) Diffusion effects of clean water supply

The clean water diffusion rate in the Bangkok metropolitan area was approximately 84% at the end of 1998. Compared to the diffusion rates of 25% in Jakarta, 71% in Manila, 100% in Kuala Lumpur[22] and others, it is a respectable level. In 1998 the diffusion rate fell due to the extraordinary growth in population between 1997 and 1998. The population supplied with water is rising steadily.

Table 2.10 Actual Record of Waterworks Diffusion Rate

FY	1990	1991	1992	1993	1994	1995	1996	1997	1998
Diffusion rate (%)	68.5	71.3	75.7	77.7	80.0	82.2	83.7	85.7	84.2
Water supply population (1,000 people)	4,842	5,138	5,400	5,583	5,792	5,959	6,124	6,307	6,369
Population in the metropolitan area (1,000 people)	7,070	7,206	7,133	7,186	7,239	7,251	7,317	7,362	7,563

(Source: MWA Materials)

[21] It indicates seven areas: Minburi, Bang Yai, Sai Noi, Bang Phlee, Bang Bo, Nong Chok and Bang Bua Thong
However, the pipeline lying construction is now underway to unite the separate system and the central system and scheduled to be completed in FY 2001.

[22] Source: Water Utilities Data Book, Asian and Pacific Region, ADB published in 1993.

Table 2.11 Water Supply Area

FY	1990	1991	1992	1993	1994	1995	1996	1997	1998
Water supply area (km^2)	680	710	740	784.4	822.3	892.9	968.9	1,096.4	1,115.0
Growth rate over the previous year (%)	8.8	4.4	4.2	6.0	4.8	8.6	8.5	13.2	1.7

(Source: MWA Annual Report)