Thailand

FY2015 Ex-Post Evaluation of Japanese ODA Loan Project

"Seventh Bangkok Water Supply Improvement Project (I)"

"Seventh Bangkok Water Supply Improvement Project (II)"[1]

External Evaluator: Keisuke Nishikawa, Japan Economic Research Institute Inc.

0. Summary

In this project, water treatment plants and transmission tunnels were developed to establish a well-balanced water supply system and respond to the growing demand for water from both sides of Chao Phraya River in the metropolitan Bangkok area. This project was consistent with the development plans and needs of Thailand at the time of appraisal and ex-post evaluation, as well as the priority areas of Japan's ODA policy at the time of appraisal. Therefore, the relevance of this project is high. With regard to project implementation, although some of the project components were changed, the changes were appropriate for generating project effects, and the project cost was within the plan. However, the efficiency was fair as the project period substantially exceeded the plan due to the effects of policy changes, etc. With respect to project effectiveness, the targets for the majority of quantitative indicators were achieved and the qualitative effects were also sufficiently achieved. As for the impact of the project, it was confirmed that this project contributed to the reduction of groundwater pumping and created a convenience for the residents in their lives. Therefore, the effectiveness and impact of this project are high. Regarding sustainability, there were no issues in terms of all institutional, technical and financial aspects, and operation and maintenance status. Therefore, project effects generated in this project are considered sustainable.

In light of the above, this project is evaluated to be highly satisfactory.

[1] In this report, the "Seventh Bangkok Water Supply Improvement Project (I)" is referred to as "Phase I" and the "Seventh Bangkok Water Supply Improvement Project (II)" as "Phase II".

1. Project Description

Project Location

Maha Sawat Water Treatment Plant Expanded in this Project

1.1 Background

Concurrent with the population growth in the metropolitan Bangkok area, the maximum demand volume of water had been expected to grow from 4.26 million m^3/day in 1999 to 5.42 million m^3/day in 2007. In those days, the water supply system in the metropolitan Bangkok area was dependent on the treatment capacity of the Bang Khen Water Treatment Plant located on the eastern side of Chao Phraya River. The water treated and produced at the plant was supplied to the plant through existing transmission tunnels and distribution pipes, but the transmission tunnels had water leakages due to their technical designs and dilapidation, undermining the transmission capacity of the water produced. Meanwhile, the western side of the river was receiving its supply of water from the eastern side and was expecting to see a growth in population, requiring a response to the foreseeable increase in water demand associated with such growth. Moreover, in the Bangkok Metropolitan Area, as ground subsidence was significant in areas where ground water was excessively extracted, the government was trying to reduce the extraction of ground water by converting to the use of surface water.

Therefore, it was necessary to establish a well-balanced network of water treatment, transmission and distribution throughout the entire metropolitan Bangkok area as a response to the increase in demand for supplied water, which came about by converting away from the use of ground water as a measure for supplying it to an increased population

and the ground subsidence issue. The Metropolitan Waterworks Authority (hereinafter referred to as 'MWA') was implementing this initiative as the 'Seventh Bangkok Water Supply Improvement Project' which this project was intended to support.

1.2 Project Outline

The objective of this project was to establish a well-balanced water supply system and respond to the increasing demand for water by strengthening treatment and transmission capacities in the Bangkok Metropolitan Area, thereby contributing to the improvement of public health and the living environment.

<ODA Loan Project>

Loan Approved Amount/ Disbursed Amount	(Phase I) 12,608 million yen / 5,752 million yen (Phase II) 9,601 million yen / 6,641 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	(Phase I) September 1999 / September 1999 (Phase II) September 2000 / September 2000	
Terms and Conditions (Both for Phase I and Phase II)	Interest Rate	Construction: 1.70% Consulting Services: 0.75%
	Repayment Period (Grace Period)	Construction: 25 years (7 years) Consulting Services: 40 years (10 years)
	Conditions for Procurement:	Construction: General Untied Consulting Services: Bilateral Tied
Borrower / Executing Agency	Metropolitan Waterworks Authority / Metropolitan Waterworks Authority	
Final Disbursement Date	(Phase I) January 2006 / (Phase II) April 2013	
Main Contractor (Over 1 billion yen)	(Phase I) Civil works: Sino-Thai Engineering and Construction Public Co., Ltd. (Thailand), OTV SA (France) / Summit Grade Limited Partnership (Thailand) (Phase II) Civil works: Italian-Thai Development Public Company Limited (Thailand) Supply of Materials and Equipment: Joint Venture TPS (Thailand)	

Main Consultant (Over 100 million yen)	(Phase I) Nihon Suido Consultants Co., Ltd. (Japan) / TEAM Consulting Engineering and Management Co., Ltd. (Thailand)
Feasibility Studies, etc.	Re-revised Master Plan for Water Supply and Distribution of Metropolitan Bangkok (1990), Safege Consulting Engineers (France) / Thai DCI Co. (Thailand)
Related Projects	[Technical Cooperation] The National Waterworks Technology Training Institute Project (1985 – 1991) The National Waterworks Technology Training Institute Project (II) (1994 – 1999) Technical Assistance Related to "Eighth Bangkok Water Supply Improvement Project" (2010 – 2013) [ODA Loan Project] Bangkok Water Supply Improvement Project (Stage I Phase II) (June 1979) Bangkok Water Supply Improvement Project (II-I) (September 1984) Bangkok Water Supply Improvement Project (Stage 2 – Phase 1 – A2) (October 1985) Bangkok Water Supply Improvement Project (Tunnel Rehabilitation) (November 1988) Bangkok Water Supply Improvement Project (Stage 2 – Phase 1 – B) (November 1988) The Fourth Bangkok Water Supply Improvement Project (Phase I) (September 1991) Fourth Bangkok Water Supply Project (II) and Fifth Project (January 1993) Networks System Improvement Project (September 1993) Sixth Bangkok Water Supply Improvement Project (September 1994) Eighth Bangkok Water Supply Improvement Project (December 2009)

	[Grant Aid] Construction of National Waterworks Technology Training Institute (1985 – 1986) [Other International / Aid Organizations] World Bank: Bangkok Water Supply Improvement Project (Stage I Phase I) (1974) Asian Development Bank: Three projects during the period of Bangkok Water Supply Improvement Project (Stage I Phase II) and (Stage II Phase I) (1974 – 1984)

2. Outline of the Evaluation Study

2.1 External Evaluator

Keisuke Nishikawa, Japan Economic Research Institute Inc.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: August 2015 – October 2016

Duration of the Field Study: December 15 – 29, 2015, and March 9 – 16, 2016

3. Results of the Evaluation (Overall Rating: A[2])

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance to the Development Plan of Thailand

The national development plan at the time of appraisal of this project was the "Eighth National Economic and Social Development Plan (1997 – 2001)", with 'Human-centered Development' as its basic concept. In the plan, seven development strategies were listed including a strategy to achieve human development by strengthening economic competitiveness and to improve the quality of life. In this plan, five basic principles for the water supply sector in the Bangkok Metropolitan Area, such as 'to promote water resource management based on economy, efficiency, priority and fairness, were set. Also in the 'Re-revised Master Plan for Water Supply and Distribution of Metropolitan Bangkok (Re-revised Master Plan) prepared in 1990, a plan to extend the total length of transmission pipes to 126.6km by 2015 and the distribution network to 34,700km by 2017 was outlined. Concerning the ground subsidence issue, there was a plan to supply water by establishing a tunnel network as a substitute for the extraction of ground water.

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[3] ③: High, ②: Fair, ①: Low

In the "Eleventh National Economic and Social Development Plan" (2012 – 2016), a national development plan at the time of ex-post evaluation, six priorities were listed including a strategy for restructuring the economy toward quality growth and sustainability. In the strategy, the aim of water sector development was to strengthen water supply capacities in both urban and rural areas in terms of both quality and quantity. The Re-revised Master Plan was also operative at the time of ex-post evaluation.

As stated above, the goals of national plans to try to improve water supply remained the same, at both the time of appraisal in the "Eighth National Economic and Social Development Plan" and the ex-post evaluation in the "Eleventh National Economic and Social Development Plan". The overall plan of the water supply sector had remained unchanged from the time of appraisal till ex-post evaluation, with the expansion of water supply networks consistently emphasized. Therefore, this project, which strengthened water production and transmission capacities including the cessation of ground subsidence in the Bangkok Metropolitan Area, can be said to have been consistent with the development plans at the time of appraisal and ex-post evaluation.

3.1.2 Relevance to the Development Needs of Thailand

At the time of appraisal of this project, it was necessary for the water supply in the Bangkok Metropolitan Area to have a well-balanced network of water treatment, transmission and distribution throughout the entire metropolitan Bangkok area to respond to challenges such as water leakages in the existing water treatment system, increases in demand from the western side of Chao Phraya River, and increases in demand for water supply caused by the shift from the use of ground water to surface water[4].

During the ex-post evaluation, questions were asked to MWA regarding these challenges, and it was confirmed that the establishment of a well-balanced network of water treatment, transmission and distribution in both the eastern and western areas of Chao Phraya River in the Bangkok Metropolitan Area not only responded to the growth in demand from the western area but was also important from a viewpoint of crisis management in that water could be supplied from east to west or vice versa when a crisis occurred. Having additional water production capacities was also necessary to implement regular maintenance works, and having an established network was considered essential for the achievement of a stable water supply. Therefore, this project,

[4] According to the documents provided by JICA, the population of the Bangkok Metropolitan Area was expected to increase from 7.56 million in 1998 to 10.23 million in 2010. Accordingly, the maximum water demand per day was also expected to increase from 4.69 million m^3/day in 1998 to 6.12 million m^3/day in 2010.

which enhanced the water production capacity in the western area of Chao Phraya River and developed a transmission tunnel between the eastern and western areas, responded to the development needs at the time of appraisal and ex-post evaluation.

The water demand, supply capacity and number of connections in the Bangkok Metropolitan Area are shown in the table below.

Table 1: Water Demand, Supply Capacity and Number of Connections in the Bangkok Metropolitan Area

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Volume of water demand (million m^3/year)	1,173	1,224	1,251	1,250	1,282	1,282	1,317	1,361	1,377	1,406
of which in the eastern area	792	832	851	846	865	866	893	923	930	949
of which in the western area	381	392	400	404	417	416	424	438	447	457
Water supply capacity (million m^3/day)	5.52	5.52	5.52	5.52	5.52	5.52	5.52	5.92	5.92	5.92
Number of connections (in thousands)	1,743	1,804	1,860	1,920	1,965	2,018	2,060	2,114	2,171	2,227
of which in the eastern area	1,016	1,051	1,081	1,115	1,138	1,167	1,191	1,218	1,252	1,282
of which in the western area	727	754	779	805	827	850	870	895	920	945
Population in the Bangkok Metropolitan Area (in millions)	-	11.22	11.28	11.33	11.39	11.41	11.46	11.53	11.60	11.67

Source: Data provided by the Executing Agency

As shown in Table 1, from 2006 to 2015, the 'volume of water demand' increased by 20%[5] and the number of connections by 28%, indicating a more rapid increase than the population growth. In particular, the number of connections in the western area increased by 30%, surpassing the rate of increase in the eastern area. As this project enhanced the supply capacity, it can be deemed a project capable of responding to this kind of demand increase. Accordingly, the importance of developing water supply networks in the western part of the Bangkok Metropolitan Area was high both at the time of appraisal and ex-post evaluation.

3.1.3 Relevance to Japan's ODA Policy

In the "Medium-Term Strategy for Overseas Economic Cooperation Operations"

[5] The water demand decreased by 300,000m^3 from 2008 to 2009, and according to the Executing Agency, this was due to the economic slowdown influenced by continuous occurrences of global financial crises after September 2008.

prepared by JICA in 1999, three priority areas were listed, including 'poverty reduction and assistance for economic and social development'. Also JICA's "Country Assistance Strategy for Thailand" prepared in 2000, specified the water supply sector as a priority area for assistance. Moreover, Japan's "Country Assistance Policy for Thailand', formulated in March 2000, prioritized economic infrastructure development.

In this way, social infrastructure development and social development implemented in this project can be said to have been consistent with these policies as the development of a water supply system was meant to support sustainable economic growth through the development of economic and social infrastructure and industries, as well as promote equitable distribution of the outcomes of economic growth through poverty reduction measures and social development. The water supply sector was also set as a priority area for assistance in the Country Assistance Policy and the Country Assistance Strategy from the viewpoint of economic infrastructure development, demonstrating a high consistency as a whole with Japan's ODA policy at the time of appraisal.

As shown above, it was confirmed that this project had been consistent with Thailand's development plans and needs at the time of appraisal and ex-post evaluation, and also with Japan's ODA policy at the time of appraisal. Therefore, the relevance of this project is judged to be high.

3.2 Efficiency (Rating:②)

3.2.1 Project Outputs

Throughout the Phase I and II of this project, the Maha Sawat Water Treatment Plant in the western area of the river and the Bang Khen Water Treatment Plant in the eastern area were expanded; transmission tunnels were constructed and rehabilitated; and trunk mains pipes, were installed. Table two summarizes the original and actual project scope.

Table 2: Original and Actual Scope of this Project

Scope	Original	Actual
[Phase I]		
Expansion of Maha Sawat Water Treatment Plant	Expansion of treatment capacity by additional 400,000m^3 per day. Procurement and installation of electrical substation. Procurement and installation of pump equipment at: - Tha Chin Raw Water Pumping Station (1 unit) - Maha Sawat Raw Water Pumping Station (3 unit) - Maha Sawat Transmission Pumping Station (1 unit) - Petch Kasem Distribution Pumping Station (1 unit)	No installation of pump equipment at Tha Chin Raw Water Pump Station. Other components were implemented as planned.
Construction of transmission tunnel	From Nakhon Indra Project Road to Tha Phra Pumping Station: Approximately 3km-long and 2,500mm in diameter	Implemented as planned
Expansion of Bang Khen Water Treatment Plant	Expansion of treatment capacity by additional 400,000m^3 per day. Expansion of Raw Water Pumping Station at Sam Lae. Expansion of Bang Khen Transmission Pumping Station. Procurement and installation of pump equipment at: - Sam Lae Raw Water Pumping Station (1 unit) - Bang Khen Raw Water Pumping Station (1 unit) - Bang Khen Raw Water Pumping Station (3 unit)	Implemented as planned
Civil Works for Unaccounted-for-Water	Civil works for Unaccounted-for-Water Pilot Project implemented under consulting services	Implemented as planned
Consulting Services	Detailed designing, bidding assistance, construction supervision, environmental monitoring, etc. for the expansion of water treatment plants, installation of transmission tunnel, and so on. Surveys, project planning, bidding assistance, construction supervision, environmental monitoring, etc. for the Unaccounted-for-Water Pilot Project	Implemented as planned

[Phase II]		
Rehabilitation of Existing Transmission Tunnel	Steel-lining works for the rehabilitation of three damaged sections (13.6km in total) of the transmission tunnel from the Bang Khen Water Treatment Plant	Rehabilitation of 0.18km-section from Lumpini Valve Chamber to Lumpini added. Other components were implemented as planned.
Installation of Trunk Mains Pipes	New installation and replacement of trunk mains pipes (161km in total: 106km for new installation and 55km for replacement)	Implemented as planned
Consulting Services	Bidding assistance and construction supervision for the rehabilitation of transmission tunnels and advice on environmental conservation measures	Implemented as planned

Sources: Information provided by JICA, and interviews with the Executing Agency

The reason not to install pump equipment at Tha Chin Raw Water Pump Station during Phase I was that it became clear in the technical survey conducted by MWA that water transmission from the pumping station, located upstream, to the Maha Sawat Water Treatment Plant, located downstream, would be possible without raising the pressure head by using a pump. Therefore, a pump to transmit water from Tha Chin Raw Water Pumping Station to Maha Sawat Water Treatment Plant was judged to be unnecessary for some time, and in fact, the water volume transmitted to Maha Sawat Water Treatment Plant had been sufficient. With regard to the additional rehabilitation of the 0.18km-section of the transmission tunnel between the Lumpini Valve Chamber and Lumpini during Phase II, the reason to include the section for rehabilitation work was that the section was found to have water leakages during the detailed designing stage.

Both Phase I and II underwent changes during the detailed designing stage such as the cancellation of pump equipment installation at the raw water pumping station and the additional rehabilitation of the transmission tunnel, which were changes that would not negatively affect the project effects. Therefore, it can be judged that there were no problems regarding these changes. Other outputs were confirmed to have been implemented when project sites other than the transmission tunnels buried underground were visited.

Bang Khen Water Treatment Plant
(section expanded in this project)

Pump installed in this project
(Phet Kasem Distribution Pumping Station)

3.2.2 Project Inputs

3.2.2.1 Project Cost

Phase I of this project was planned at a cost of 17,254 million yen, including the ODA loan amount of 12,608 million yen, and Phase II at 15,253 million yen, including the ODA loan amount of 9,601 million yen. Table 3 compares the original and actual amounts for each phase.

Table 3: Comparison of Original and Actual Project Cost (by overall cost and loan amount)

(Unit: million yen)

	Original		Actual	
	Overall cost	of which the loan amount	Overall cost	of which the loan amount
Phase I	17,254	12,608	9,126	5,752
Phase II	15,253	9,601	12,041	6,641
Total	32,507	22,209	21,167	12,393

Source: Data provided by JICA and the Executing Agency

Although the project cost planned at the time of appraisal was based on the preparatory study, the cost was reduced[6] during the detailed designing stage, as there were cases of competitive bidding among contractors for each contract package after that and the actual quantity of construction works turned out to be less than the

[6] For example, cancellation of pump installation at Tha Chin Raw Water Pumping Station reduced the project cost by 458 million yen. Also, regarding the addition of the transmission tunnel rehabilitation in the Lumpini area, the cost of the contract package including other work sections was in fact 2,203 million yen, less than the planned amount of 2,981 million yen, though the package had a variation order.

quantity initially expected; all of which led to the reduction of the overall cost[7].

As a result of detailed design and bidding, the installation of pump equipment at the raw water pumping station was cancelled and the transmission tunnels were additionally rehabilitated. The actual overall project cost combining Phase I and II was 21,167 million yen which was 35% lower than the planned amount.

3.2.2.2 Project Period

The period of this project was expected to be 78 months from September 1999 to February 2006, with Phase I continuing 61 months, from September 1999 to September 2004, and Phase II proceeding 66 months, from September 2000 to February 2006. Table 4 summarizes the original and actual project period.

Table 4: Comparison of Original and Actual Project Period

	Original	Actual	Changes
Phase I	September 1999 – September 2004 (61 months)	September 1999 – September 2007 (85 months)	139%
Phase II	September 2000 – February 2006 (66 months)	September 2000 – March 2014 (163 months)	247%
Total	September 1999 – February 2006 (78 months)	September 1999 – March 2014 (175 months)	224%

Source: Information provided by JICA and the Executing Agency

As shown in the table above, both Phase I and II exceeded the planned periods. The primary reasons are described below.

[Phase I]

- In December 2003, a polder dyke within the premises of Bang Khen Water Treatment Plant, which was outside the scope of this project, collapsed causing sludge to flow into the construction area. Consequently, it took 18 months for the recovery work to conclude causing delays of related work associated with recovery work, and led to an overall delay of 24 months.

[Phase II]

- During the project implementation, the Government of Thailand banned the

[7] As stated later, the project period exceeded the plan as a polder dyke at Bang Khen Water Treatment Plant collapsed and sludge flowed into the construction area within the transmission pumping station. While the cost increased due to recovery work, it is not included in the cost of this project as the inflow of sludge into the transmission pumping station was caused due to the collapse of the facility (dyke) that was outside the project's scope.

excavating of wells in the southeastern area of the Bangkok Metropolitan Area causing a substantial increase in demand for water in that area. In this project, some parts of the water supply system were planned to be cut off due to the rehabilitation work on transmission tunnels, but some concerns arose over the transmission capacity to the southeastern area and the stability of the water supply system during that period. As a consequence, a new transmission tunnel funded by MWA was planned for construction before the transmission tunnel of this project was to be rehabilitated. It took four years to complete this new plan.

- The International Competitive Bidding System was adopted in this project, but a significant delay occurred upon its procedure.
- Due to the occurrence of large-scale flooding in and around Bangkok in 2012, a company of one of the contract packages incurred various influences, such as having to undertake preventative work so that flood water would not flow into the construction site, difficulties in securing construction materials and manpower, and a closure of roads leading to the construction site. As it was expected that the initial contract completion date would not be met, the contract period was extended by 210 days as a measure to support that company (Cabinet resolution in March and May 2012).
- A delay in the construction of Maha Sawat Water Treatment Plant in the "Eighth Bangkok Water Supply Improvement Project" (commenced in 2010) required an adjustment to postpone the commencement of rehabilitation work on the transmission tunnel (Route 2) for this project.

As stated above, various factors were related to the delay of the project. As the large-scale flooding in and around Bangkok during Phase II, which caused such widespread effects, was said to be one that would occur only once every few decades, the extended period of 210 days was subtracted from the calculation of the project period.

Therefore, with Phase I and II combined, it can be judged that the actual period was 168 months (with the dates September 1999 – March 2014 equaling 175 months and minus 7 months), compared to the planned period of September 1999 – February 2006 (78 months). The actual project period was significantly longer than planned as it became 215% that of the original plan.

3.2.3 Results of Calculations of Internal Rates of Return (Reference only)

Financial Internal Rate of Return (FIRR)

It was expected at the time of appraisal that the FIRR of Phase I would be 16.2% and the overall FIRR including the 'Seventh Bangkok Water Supply Improvement Project', supported by Japan, be 10.6%. On the other hand, the FIRR for Phase II had not been calculated at the time of appraisal. Therefore, the overall FIRR of the 'Seventh Bangkok Water Supply Improvement Project' was recalculated in this ex-post evaluation study. In the same way as the calculation at the time of appraisal, the benefits were considered revenues from water rates, meter installation, and equipment (installation of water taps), and the costs were considered construction costs, water treatment costs, meter reading/fees collection costs, maintenance costs, and interest rates. The project life was set for 30 years.

The recalculation of the FIRR for the overall 'Seventh Bangkok Water Supply Improvement Project' in the ex-post evaluation showed a result of 9.31%, which was higher than the weighted average cost of capital, of 7.82%. The main reason for the rate being lower than the plan was that water rates and new connection fees had not been raised. However, it was considered the appropriate investment as it was higher than the weighted average cost of capital.

Regarding the output in this project, while there were some changes such as the cancellation of pump equipment at Tha Chin Raw Water Pumping Station and the extension of a transmission tunnel by 0.18km, they were considered adequate as these were not changes that damaged the generating of project effects, as stated above. The actual overall project cost as a result was within the plan, at 65% of the planned project cost. On the other hand, the project period significantly exceeded the plan 215% resulting from the inflow of sludge caused by the collapse of the adjacent polder dyke and the suspension of the transmission tunnel construction associated with the ban on the excavating of wells.

In light of the above, although the project cost was within the plan, the project period exceeded the plan. Therefore, the efficiency of the project is fair.

3.3 Effectiveness[8] (Rating:③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

In this project, no indicators to measure project effects were set at the time of appraisal of Phase I, but the operation and effect indicators, shown in the table below, were set at the time of appraisal of Phase II, one year later. Therefore, actual figures of these indicators were checked and their achievement levels were evaluated in the ex-post evaluation study.

[8] Sub-rating for Effectiveness is to be put with consideration of Impact.

Table 5: Operation and Effect Indicators of this Project

			Baseline	Target	Actual	Actual	Actual
			1999	2007	2013	2014	2015
			Appraisal Year	1 Year After Completion	1 Year Before Completion	Completion Year	1 Year After Completion
Operation Indicator	Average Water Production (million m^3/day)		3.88	4.93	4.94	4.92	5.03
	Unaccounted-for-Water Rate (%)		39.4	30.0	24.6	23.4	22.1
	Leakage Rate (%)		32.0	26.0	No data		
	The following indicators for Petch Kasem Distribution Station						
	1. Water Supply Volume (million m^3/day)		0.26	0.38	0.27	0.34	0.35
	2. Water Pressure (m)		23.0	42.0	18.9	22.3	26.2
	3. Size of area without any or without sufficient water supply (km^2)		20.0	10.0	No data		
Effect Indicator	Water Supply Coverage (%)	Population-based	64.0	67.0	99.0	99.3	99.5
		Area-based	37.3	45.6	80.0	81.3	No data

Source: Data provided by JICA and the Executing Agency

As the figures set as targets for 2007 at the time of appraisal were the ones to be achieved one year after project completion, comparisons were made with the figures of 2015 which were accounted for one year after the actual completion of this project. It was confirmed that the Average Water Production, Unaccounted-for-Water Rate, Water Supply Coverage (population- and area-based) were above the targets. The water leakage rates are not recorded at MWA as they were captured in the Unaccounted-for-Water Rates. As the Unaccounted-for-Water Rate was 22.1%, the actual leakage rate was thought to be less than that rate.

While the water supply volume and water pressure from Petch Kasem Distribution Station were lower than the planned figures, real-time and sufficient distribution including supply from other distribution stations to the supply area were achieved in response to the demand. As the optimal water supply in the entire water supply network was made possible, no supply shortage occurred in reality, and the surplus supply capacity at Petch Kasem Distribution Station was to be used for increases in demand for water in the future. Regarding the supply area, it was presumed that water was distributed to almost all residential areas as the population-based water coverage rate in

the Bangkok Metropolitan Area, covered by MWA, was 99.5% (2015).

In addition to the indicators expected at the time of appraisal, maximum water supply volume and water production capacities were realized, which is shown below.

Table 6: Water Production and Supply in the Bangkok Metropolitan Area

Indicator	2011	2012	2013	2014 (Completion Year)	2015 (1 Year After Completion)
Maximum Water Supply Volume (million m^3/day)	5.17	5.31	5.43	5.42	5.42
Water Production Capacity (million m^3/day)	5.52	5.52	5.92	5.92	5.92

Source: Data provided by JICA and the Executing Agency

The water production capacity increased by 400,000m^3/day at Bang Khen and Maha Sawat Water Treatment Plant through implementing this project, and it became 3.6 million m^3/day at Bang Khen Water Treatment Plant and 1.2 million m^3/day at Maha Sawat Water Treatment Plant. Together with other smaller water treatment plants, water production capacity in the Bangkok Metropolitan Area had become 5.52 million m^3/day since 2006 and had stably catered to demand for water from the late 2000s till the early 2010s.

In this ex-post evaluation study, opinions of residents regarding the stability of water supply and water quality, etc. were obtained in a beneficiary survey[9]. 95% of the residents responded that water supply was ‘very stable’ or ‘stable’, and 81% responded that the stability ‘improved a lot’ or ‘improved’ compared to the situation before the completion of the project. 12% responded that there was no change before and after the project as it had already been stable for them. Regarding the water quality, 97% responded that it was ‘good’ or ‘acceptable’, and 96% responded that the water pressure was ‘good’ or ‘acceptable’. In this way, it was observed in the beneficiary survey that water users evaluated the improvements highly in terms of water supply stability, water quality and water pressure.

As stated above, quantitative effects were broadly generated as many of the indicators in this project achieved the targets set at the time of appraisal ahead of schedule as a whole.

[9] Three districts in the Bangkok Metropolitan Area (40 each, 120 effective responses) were extracted based on judgment sampling. In each district, interview surveys with residents (75%), shops (23%) and factories (2%) were conducted in three groups.

3.3.2 Qualitative Effects (Other Effects)

At the time of appraisal of this project, it was expected that two qualitative effects, 'establishment of a well-balanced water supply system on the eastern and western sides of Chao Phraya River' and 'presentation of effective measures for Unaccounted-for-Water', would be generated through implementing the project.

With regard to the first effect, i.e., the establishment of well-balanced water supply system on the eastern and western sides, as Maha Sawat Water Treatment Plant came to have a supply capacity of 1.2 million m^3/day with the expansion of 400,000m^3/day through implementing this project, the demand on the western side of Chao Phraya River was met. It can be said that water supply was optimized as the water supplied from the eastern side was minimized.

As to the second effect of the presentation, i.e., effective measures for Unaccounted-for-Water, a pilot project was implemented in Tungmahamek, Sathorn District as part of the consulting services. In the pilot project, construction of a valve chamber, repair of damage causing water leakage, and replacement of water pipes were conducted and a non-revenue-water management including proactive leakage management, rapid repair, water pressure management, and infrastructure management with the use of an information management system was implemented. According to the Executing Agency, this experience led to an overall improvement in the capacities of those concerned with non-revenue-water management. After receiving support and training for this project, and support from the waterworks bureaus of Japanese local governments through technical cooperation projects and technical assistance related to ODA loan project, they implemented non-revenue-water management independently, which was considered to have led to a substantial improvement in the Unaccounted-for-Water rates, shown in Table 5. After that, MWA formulated the "Water Leakage Management Master Plan" in 2012 and had been making efforts in the field of water management, which were in line with standards set by the International Water Association[10]. Therefore, it can be judged that the 'presentation of effective measures for Unaccounted-for-Water', expected at the time of appraisal of this project, was implemented.

3.4 Impacts

3.4.1 Intended Impacts

At the time of appraisal, the following impacts through project implementation were

[10] A not-for-profit international organization established in 1999 to supply stable and safe water and contribute to public health in the world through efficient management of water and improvement of water treatment techniques. Approximately 130 countries are the members.

expected.

- New installation of water trunk, i.e., pipes, and a water supply system in areas where ground water was used would contribute to the easing of ground subsidence.
- Prevention of water leakage from the transmission tunnel would stop the erosion of underground soil and prevent secondary accidents such as damage to roads.

There were some areas in the Bangkok Metropolitan Area where ground subsidence had become a problem, and its cause was thought to be excessive pumping of ground water. During the implementation of this project, the excavating of new wells was banned and levies on ground water pumping were imposed. While the ground subsidence issue was under the jurisdiction of the Ministry of Natural Resources and Environment, not MWA, MWA contributed to the resolution of this issue through developing water supply networks. Also, efforts had been made on the prevention of leakages by rehabilitating transmission tunnels in this project and others, and it was assumed that the actual erosion of underground soil and disasters such as road sagging could be prevented.

According to MWA, no reports were received from residents saying that ground subsidence cases had occurred due to water supply or that road sagging cases had occurred due to water leakage of transmission tunnels. In the beneficiary survey, 78% of residents responded that ground subsidence had not occurred. The remaining 22% replied that ground subsidence had continued. Common comments on the ground subsidence issues were that though they were occurring in some areas, they were improving compared to the past. The factors considered were that ground water pumping was not totally abolished and that influences of past pumping were still seen in some areas. However, it is inferred that this project made a certain level of contribution to the reduction of ground water pumping.

Regarding ‘changes in lifestyle’ in the beneficiary survey and excepting the impacts mentioned above, there were opinions that residents’ lifestyles had become more convenient with the improvements in water supply and increase in number of coin-operated launderettes, implying that this project also contributed to the enhancement of convenience.

3.4.2 Other Impacts

3.4.2.1 Impacts on the Natural Environment

During the planning stage, it was expected that the implementation of this project would improve the hygiene of the residential environment by enabling residents to access safe water and improving their living environment.

Impacts to the natural environment were checked through MWA in the ex-post evaluation and no negative impacts to environment had been seen during nor after the project implementation. In the beneficiary survey, a majority, comprising 98% of residents, responded that there were no particular problems while 2% replied that a type of sandy dust was generated during the water pipe installation works. As for water-borne diseases such as cholera and diarrhea, caused by unsafe water, all of the respondents replied that there were no such cases.

It was reported by MWA that no asbestos-cement pipelines were used during the implementation of this project, and no negative environmental effects were expected in this regard.

Based on the above, it was considered that there were no problems as a whole, as it became clear from the information provided by MWA and the beneficiary survey that no water-borne diseases had developed and no negative effects on the natural environment had been observed in particular, either during or after the project.

3.4.2.2 Land Acquisition and Resettlement

In regard to land acquisition and resettlement in this project, it was expected that

- Phase I: The land outlined for the project had been acquired and there would be no resident resettlement.
- Phase II: No land was going to be acquired for tunnel rehabilitation or installation of trunk mains, and there would be no resident resettlement.

According to MWA, the land for the water treatment plant (approximately 1km^2) was purchased from a private owner and this land was used in this project. There were no issues as the land had already been purchased from the private owner for the future expansion even before this project was planned. It was reported that no resident resettlement occurred in this project, and a visit to the project site in the ex-post evaluation study implies that there was no resident resettlement.

Therefore, it can be judged that there were no problems on the process of land acquisition and resettlement.

With regard to the operation and effect indicators used to measure the effectiveness of this project, no data for some of the indicators could be found. However, with other

indicators considered, it can be judged that the targets were achieved for all indicators except those at Petch Kasem Distribution Station. For Petch Kasem Distribution Station, while the indicators of the distribution station itself had not been achieved, it was not a problem as a stable supply had been realized under the integrated management including the supply at other distribution stations. The qualitative effects were also sufficiently achieved.

Regarding the impact, it was seen that the project had contributed to the reduction of ground water pumping and the residents' lifestyles had become more convenient. No issues were found in terms of environmental and socials aspects.

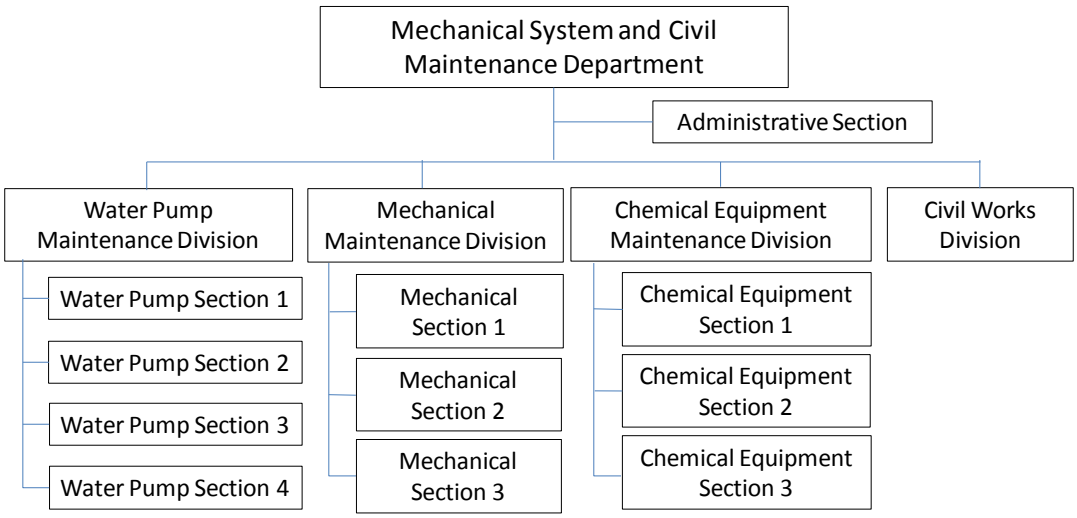
In light of the above, this project has largely achieved its objectives. Therefore, the effectiveness and impact of the project are high.

3.5 Sustainability (Rating:③)

3.5.1 Institutional Aspects of Operation and Maintenance

The executing agency of this project was MWA, under the Ministry of Interior, consisting of 9 bureaus including the Governor's Office, Administration, Finance, Planning and Development, Engineering and Construction, Water Production and Transmission, Eastern Services, Western Services and Information Technology. The number of staff was 4,137 (as of December 2015). The number had decreased by more than 2,000 staff members since the time of appraisal of this project, and this was because MWA had already started reducing the number of staff to achieve efficient management before that time. According to MWA, new employment was limited to 25% of the total retirement, and it was concluded through analysis that the authority could be downsized to a level where the ratio of staff to customers would be 1:400. At the time of ex-post evaluation, the number of staff was reduced to that ratio. However, judging from the operation and maintenance status, the needed number of technicians seemed to have been sufficiently employed.

Operation and maintenance of this project was undertaken by each department and section of Bang Khen and Maha Sawat Water Treatment Plants, etc. under the management of Deputy Governor, who was in charge of production and transmission. The Mechanical System and Civil Maintenance Department was in charge of maintenance of facilities and equipment. The department consisted of 4 divisions, the Water Pump Maintenance Division, the Mechanical Maintenance Division, the Chemical Equipment Maintenance Division etc., with 101 staff members.



Source: Information provided by the Executing Agency

Figure 1: Organization Chart of Mechanical System and Civil Maintenance Department

Regarding the structure of operation and maintenance, MWA had a clear demarcation of roles by division and it was felt from the actual operation and maintenance status that it had the structure to conduct sufficient operation and maintenance.

At the time of appraisal of this project, there was the possibility that at a time of a series of privatizations of state-owned enterprises in Thailand, MWA would also be privatized; but it was not carried out with the change of government after all. It was confirmed that privatization was not being planned at the time of ex-post evaluation.

3.5.2 Technical Aspects of Operation and Maintenance

MWA expressed their view that it had sufficient capacities and technical skills within their authority to operate the water supply business and maintain facilities and equipment. In fact, there were no facilities left unrepaired, and as described earlier, the beneficiary survey showed that 95% of the respondents answered that water was supplied stably, indicating sufficient technical skills for operation and maintenance. While repairs and overhauls of pumps, motors, clarifying and filtering facilities were outsourced to the private sector, there were no issues observed in terms of optimal and efficient maintenance. According to MWA, manuals on operation and maintenance were prepared and provided for each contract package of this project and were utilized for maintenance work.

With respect to capacity development of maintenance technicians, internal training programs such as training on maintenance of pumping equipment as well as a vibration analysis training conducted by an external organization were provided to develop capacities of technicians. Japan also provided assistance for capacity development of

technicians between the 1980s and 1990s and then again in the early 2010s, in addition to the support by 'Bangkok Water Supply Improvement Project', implemented several times.

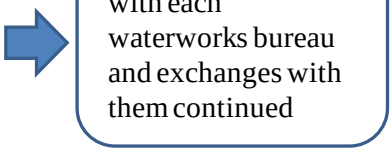
Column: Long-term Cooperation by Japanese Local Governments for Capacity Development of MWA's Technicians

The National Waterworks Technology Training Institute was constructed through the Grant Aid Project: 'Construction of National Waterworks Technology Training Institute' in 1986, and Technical Cooperation: 'The National Waterworks Technology Training Institute Project' (1985 – 1991 and 1994 – 1999) and Technical Assistance related to 'Eighth Bangkok Water Supply Improvement Project' (2010 – 2013) (hereinafter referred to as 'Related Technical Assistance') were implemented with the cooperation of technicians from Japanese water supply corporations from the Tokyo Metropolitan Government, Nagoya City, Osaka Prefecture, Sapporo City, Yokohama City, Saitama Prefecture, etc. During and after that period, MWA hosted JICA's Third Country Training Programs[11] in areas such as water supply technologies and water supply business management, and had become a hub in the Asian region to disseminate water supply technologies which Thailand had learned.

In the Technical Cooperation project being implemented before the commencement of this project, the conducting of training, research and development activities were done in water resource management, advanced technologies of water purification, non-revenue-water volume management, etc., and the technicians came to acquire technical skills for responding to increases in water demand and realizing stable water supply. However, when the 'Eighth Bangkok Water Supply Improvement Project', a successor of this project, was planned for implementation, it was found that leakage management, distribution management, pipeline designing, water purification, etc. needed to be supported further, and Tokyo Metropolitan Government, Nagoya City and Osaka Prefecture cooperated in the Related Technical Assistance.

[11] A scheme in which a certain developing country (i.e. a country that received technical assistance from Japan in the past) hosts technicians from other developing countries with support from donor countries or organizations for the purpose of transfer or sharing of development experiences, knowledge and technology

Technical Assistance Related to "Eighth Bangkok Water Supply Improvement Project"	
Tokyo	Non-Revenue-Water Management
Nagoya	Water Distribution Management
Osaka Prefecture	Water Supply –Transmission Management / Risk Management



MWA improved their technical skills in the above fields through the Related Technical Assistance and was making efforts to further lower the non-revenue-water rates by reducing water leakage. After the completion of Related Technical Assistance, a Memorandum of Understanding was signed with each waterworks bureau to continue future exchanges.

MWA had continued a cooperative relationship with JICA and become an important partner for JICA, as it continued to host JICA's Third Country Trainees from many parts of the world, particularly from ASEAN countries, and had been cooperating with the Thai-Japanese Association School in Bangkok on their field trips since 2004. MWA received the International Cooperation Appreciation Award from JICA in 2011.

3.5.3 Financial Aspects of Operation and Maintenance

In the ex-post evaluation study, MWA's overall revenue and expenditure and the maintenance budget of recent years were obtained. The income statement is from MWA's financial statements shown below.

Table 7: MWA's Statement of Income

(Unit: million Baht)

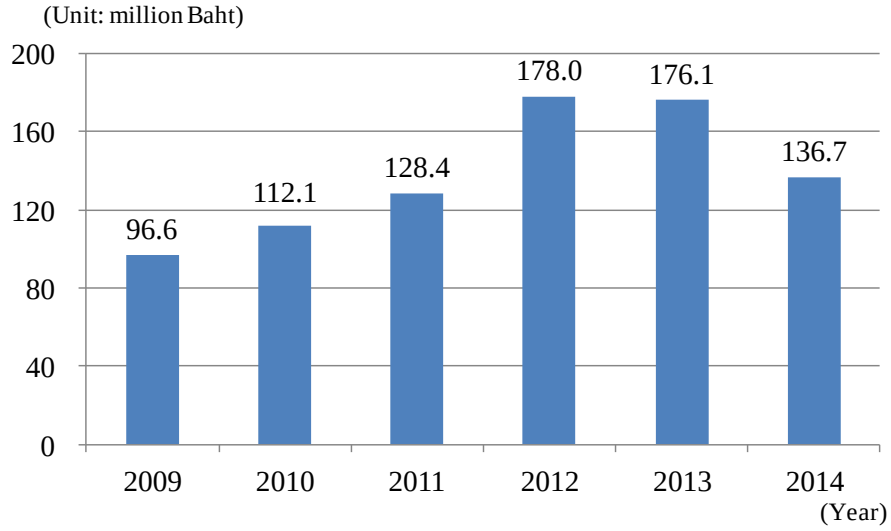
	2009	2010	2011	2012	2013	2014
[Operating revenues]						
Water sales	14,873	15,302	15,287	15,562	16,257	16,403
Water meter fees	783	805	824	844	865	888
Tap water connection fees	472	471	455	371	425	455
Work contract revenues	389	471	561	614	742	786
Other operating revenues	147	137	236	214	579	661
Total operating revenues	16,665	17,186	17,363	17,605	18,867	19,194
[Operating expenses]						
Raw materials and consumables used	1,995	1,947	2,040	2,364	2,555	2,545
Employee benefit expenses	3,289	3,463	3,420	3,188	3,249	3,269
Depreciation and amortization expenses	4,880	4,573	4,427	4,665	4,411	4,674
Other operating expenses	1,169	1,310	1,580	1,702	2,028	2,094
Total operating expenses	11,333	11,293	11,467	11,919	12,243	12,582
Operating profit	5,331	5,892	5,895	5,686	6,624	6,613
[Other revenues and expenses]	-188	159	-26	271	703	329
[Finance costs]	-641	-410	-222	-165	-83	-65
Profit for the year	4,502	5,641	5,647	5,792	7,244	6,877

Source: Data provided by the Executing Agency

Note: Individual figures and total figures may not necessarily correspond due to rounding.

It was confirmed from the income statement that revenues, particularly through water sales, were increasing, leading to sufficient net profit as the demand for water had been increasing. The financial statements including the balance sheet and the cash flow statement had no problems and were in a sound financial status.

Expenditures for maintenance of water supply facilities and equipment are as shown in Figure 2. While the expenditure decreased in 2014 from its increasing trend from till the previous year, MWA commented that necessary repairs and inspections were conducted without problems and a sufficient amount of maintenance budget was allocated.



Source: Data provided by the Executing Agency

Figure 2: Repair and Maintenance Expenses of Facilities and Equipment

The water tariff could be freely determined by MWA after the amendment of the 1992 Metropolitan Waterworks Authority Act, but it had not been raised since December 1999. For households, it was 8.50 Baht per $1m^3$ up to the first $30m^3$, above which point the water tariff per single unit gradually goes up. According to MWA, as the financial status had been sound, with increases in water sales, there was no immediate need to raise the tariff.

Based on the above, there were no particular concerns on the financial aspect, and there were no issues as a whole.

3.5.4 Current Status of Operation and Maintenance

Inspections during the ex-post evaluation of the water treatment plants and distribution station developed in this project found that all of the facilities were working in good condition. While the tunnels could not be checked visually, as they were all buried underground, all of them were used in all sections without any problems, according to MWA. At MWA, two types of maintenance plans, a preventive one and a predictive one, were formulated and used, with the former being used as a setting for the frequency of inspections; The items to be checked weekly, monthly, quarterly, biannually, yearly, every 36 and 60 months were specified. The latter plan was to analyze the status on a regular basis. According to MWA, these maintenance plans were adequately exercised with the conducting of regular inspections. MWA also regularly carried out large-scale repairs of water treatment plants and pumps and it was confirmed during the ex-post evaluation that older equipment outside the scope of this project was

being repaired.

Regarding the procurement of spare parts, a longer time was taken for non-versatile or infrequently-used parts. However, there seemed to be no problems in general as no parts went unreplaced.

During the site survey of the ex-post evaluation, no concerns were found regarding operation and maintenance.

In light of the above, no major problems have been observed in the institutional, technical and financial aspects of the operation and maintenance system. Therefore, the sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

In this project, water treatment plants and transmission tunnels were developed to establish a well-balanced water supply system and respond to the growing demand for water from both sides of Chao Phraya River in the metropolitan Bangkok area. This project was consistent with the development plans and needs of Thailand at the time of appraisal and ex-post evaluation, as well as the priority areas of Japan's ODA policy at the time of appraisal. Therefore, the relevance of this project is high. With regard to project implementation, although some of the project components were changed, the changes were appropriate for generating project effects, and the project cost was within the plan. However, the efficiency was fair as the project period substantially exceeded the plan due to the effects of policy changes, etc. With respect to project effectiveness, the targets for the majority of quantitative indicators were achieved and the qualitative effects were also sufficiently achieved. As for the impact of the project, it was confirmed that this project contributed to the reduction of groundwater pumping and created a convenience for the residents in their lives. Therefore, the effectiveness and impact of this project are high. Regarding sustainability, there were no issues in terms of all institutional, technical and financial aspects, and operation and maintenance status. Therefore, project effects generated in this project are considered sustainable.

In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Some time has passed since the facilities and equipment were developed in this project and it is assumed that major repair work will be necessary in the future. It is expected that good management, based on the maintenance plan, will be continued as

seen till now, so that the water supply will continue to be stable.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Improvement of Project Effects by Capacity Development through Long-term Technical Assistance

Not only the support for water supply network development through ODA loan projects but also the capacity development of staff members has been provided to MWA since the 1980s through the construction of National Waterworks Technology Training Institute and the provision of technical cooperation. As a result of such assistance, a reduction of Unaccounted-for-Water Rates through capacity development of technicians, who work on non-revenue-water management and, distribution management, and a stable supply of water through proper maintenance of water supply facilities have been achieved, while the facilities developed in this project have been effectively utilized. With long-term technical cooperation, the effects of facility development projects such as those seen in this project have been magnified. Therefore, when implementing a similar project, it is considered effective that the implementation capacity of the executing agency be adequately examined and capacity building assistance be provided separately or in conjunction.

(End)

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs (Phase I)		
Expansion of Maha Sawat Water Treatment Plant	Expansion of treatment capacity by additional 400,000m^3 per day Procurement and installation of electrical substation Procurement and installation of pump equipment at: - Tha Chin Raw Water Pumping Station (1 unit) - Maha Sawat Raw Water Pumping Station (3 units) - Maha Sawat Transmission Pumping Station (1 unit) - Petch Kasem Distribution Pumping Station (1 unit)	No installation of pump equipment at Tha Chin Raw Water Pump Station Other components were implemented as planned.
Construction of transmission tunnel	From Nakhon Indra Project Road to Tha Phra Pumping Station: Approximately 3km-long and 2,500mm in diameter	Implemented as planned
Expansion of Bang Khen Water Treatment Plant	Expansion of treatment capacity by additional 400,000m^3 per day Expansion of Raw Water Pumping Station at Sam Lae Expansion of Bang Khen Transmission Pumping Station Procurement and installation of pump equipment at: - Sam Lae Raw Water Pumping Station (1 unit) - Bang Khen Raw Water Pumping Station (1 unit) - Bang Khen Raw Water Pumping Station (3 units)	Implemented as planned
Civil works for Unaccounted-for-Water	Civil works for Unaccounted-for-Water Pilot Project implemented under the consulting services	Implemented as planned

Consulting services	Detailed designing, bidding assistance, construction supervision, environmental monitoring, etc. for the expansion of water treatment plants, installation of transmission tunnel, and so on Surveys, project planning, bidding assistance, construction supervision, environmental monitoring, etc. for the Unaccounted-for-Water Pilot Project	Implemented as planned
(Phase II) Rehabilitation of existing transmission tunnel	Steel-lining works for the rehabilitation of three damaged sections (13.6km in total) of the transmission tunnel from the Bang Khen Water Treatment Plant	Rehabilitation of 0.18km-section from Lumpini Valve Chamber to Lumpini added Other components were implemented as planned.
Installation of trunk mains pipes	New installation and replacement of trunk mains pipes (161km in total: 106km for new installation and 55km for replacement)	Implemented as planned
Consulting services	Bidding assistance and construction supervision for the rehabilitation of transmission tunnels and advice on environmental conservation measures	Implemented as planned
2. Project Period	(Phase I) September 1999 – September 2004 (61 months) (Phase II) September 2000 – February 2006 (66 months)	(Phase I) September 1999 – September 2007 (85 months) (Phase II) September 2000 – March 2014 (163 months)
3. Project Cost (Phase I) Amount Paid in Foreign Currency Amount Paid in Local Currency Total Japanese ODA Loan Portion Exchange Rate	 10,959 million yen 6,295 million yen (1,961 million baht) 17,254 million yen 12,608 million yen 1 baht = 3.21 yen (as of April 1999)	 5,752 million yen 3,373 million yen (1,143 million baht) 9,126 million yen 5,752 million yen 1 baht = 2.95 yen (Average between September 1999 and September 2007)

(Phase II)		
Amount Paid in Foreign Currency	9,601 million yen	2,892 million yen
Amount Paid in Local Currency	5,652 million yen (1,976 million baht)	9,149 million yen (2,854 million baht)
Total	15,253 million yen	12,041 million yen
Japanese ODA Loan Portion	9,601 million yen	6,641 million yen
Exchange Rate	1 baht = 2.86 yen (as of April 2000)	1 baht = 3.20 yen (Average between September 2000 and March 2014)