Eastern Seaboard Development Plan
Water Resource Development/ Water Pipeline Project

1. Project Summary and Japan's ODA Loan

(1) Background: Since there are few large rivers and rainfall is scarce throughout the year in the Eastern Seaboard, the apprehension arose that Eastern Seaboard would fall short of water as a result of large-scale industrial development. In order to meet increasing demands for water from development of said seaboard and to avoid water shortages which would interfere with economic and social activity, development of water resources (dams) (see Table① below) and water pipeline projects (see Tables ②-⑤ below) were planned. In addition, these projects were to be part of the Eastern Seaboard Development Plan.

(2) Objectives: To keep up with the growing demand for domestic and industrial waters in the western coastal area of Eastern Seaboard, including Laeam Chabang, and in the southern coastal area of Eastern Seaboard, including Map Ta Phut.

(3) Project Scope:

Project name	Executing agency	Remarks	
① Nong Pla Lai Reservoir Project	RID[1)]	Development of reservoirs	**In the scope of present evaluation**
② Nong Kho - Laem Chabang Water Pipeline Project	PWD[2)]	Water transmission to the western coastal area	Post evaluation was conducted before
③ Nong Pla Lai - Nong Kho Water Pipeline Project	PWD		**In the scope of present evaluation**
④Easten Seaboard (Dok Krai - Map Ta Phut) Water Pipeline Project	RID	Water transmission to the southern coastal area	Ex-post evaluation was conducted before
⑤ Map Ta Phut - Sattahip Water Pipeline Project	RID		**In the scope of present evaluation**

[1)] RID: Royal Irrigation Department, Ministry of Agriculture and Cooperatives
[2)] PWD: Public Works Department, Ministry of Interior

The ODA loan applies to full amount of the foreign currency portion and a part of the local currency portion for Projects ①, ③ and ⑤, and ODA loans cover full amount of the foreign currency portion with regard to Projects ② and ④. The evaluation items for this time are ①, ③ and ⑤; however since the five projects including ② and ④, as a whole, are to exhibit the desired effects as a network, all of the five projects are evaluated in terms of their operation and maintenance performance.

(4) Borrower/ Executive agency: Kingdom of Thailand/see Table above

(5) Outline of the Loan Agreement:

	Nong Pla Lai Reservoir Project	Map Ta Phut - Sattahip Water Pipeline Project	Nong Pla Lai - Nong Kho Water Pipeline Project

Loan Amount Loan Disbursed Amount	¥ 4,357million ¥ 3,226 million	¥ 1,459 million ¥ 1,052 million	¥ 6,362 million ¥ 4,102 million
Date of Exchange of Notes Date of Loan Agreement	September 1988 September 1988	September 1988 November 1988	December 1992 January 1993
Loan Conditions Interest Rate Repayment Period(Grace Period)	2.9% 30 years (10 years)	2.9% 30 years (10 years)	3.0% 25 years (7 years)
Final Disbursement Date	January 1995	March 1994	May 1999

2. Analysis and Evaluation

(1) Project Scope: Nong Pla Lai Reservoir Project (hereinafter referred to as ND Project), Nong Pla Lai-Nong Kho water pipeline project (hereinafter referred to as N-N water pipeline project) and Map Ta Phut-Sattahip water pipeline project (hereinafter referred to as M-S water pipeline project) were respectively implemented almost as scheduled. As part of the consulting service for the project of ND project, preliminary feasibility study for the construction of the underground dam and training of experts for such a study were added to the scope of the project.

(2) Implementation Schedule: ND project was finished 4 months earlier than the original schedule, and this performance can be said to be good. N-N water pipeline project was completed about one year behind the schedule. This delay was due to the time required for evaluating tenders and for purchasing the land, but after the construction began, the construction proceeded as scheduled without significant delay. This performance can be said to be generally good. M-S water pipeline project was completed about 2 years later than the schedule. Since the case of the delay was slow progress in selecting a consultant and contractor, administrative procedures at RID are expected to be improved further.

(3) Project Cost: The total project cost of the ND project was slightly over the original plan, and the major reason thereof was that the cost for purchasing the land was more than 1.5 times that of the original plan. The total project cost for N-N water pipeline project was about 60% of the original plan, due to tax-exemption for purchasing equipment, heated competition in biding, and depreciation of baht's exchange rate to yen. The total project cost for M-S water pipeline project was approximately the same as the original plan (around 90% of the original plan).

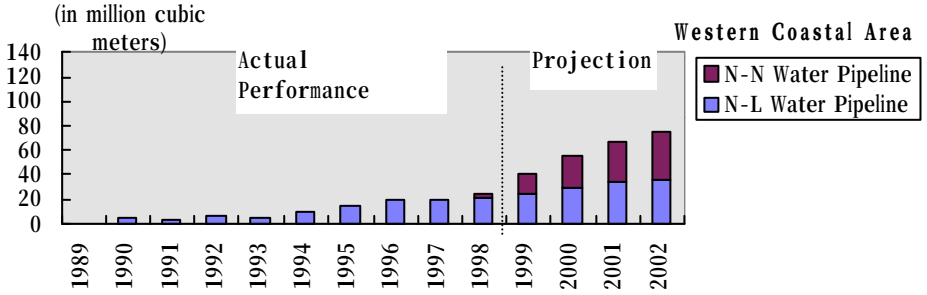
Original Plan and Performance	Original Plan	Performance
① Project Scope		
- ND project		
1. Reservoir (storage area/effective storage capacity)	22.9 km^2/151.9 million m^3	22.9 km^2/151.2 million m^3
2. Dam body height/dam body length	Homogenous earth-fill dam 23.5 m/4,060 m	Homogenous earth-fill dam 24.0 m/4,060 m
3. Other Facilities	Roads, administration building etc.	Roads, administration building etc.
- N-N Water Pipeline Project		
1. Water Pipeline	Steel pipe 1,350 mm×38.78 km Steel pipe 900 mm×4.5 km	Steel pipe 1,350 mm×38.78 km Steel pipe 900 mm×4.5 km
2. Pumping system	9 units	9 units
3. Other facilities	Flow control system	Flow control system
- M-S Water Pipeline Project		

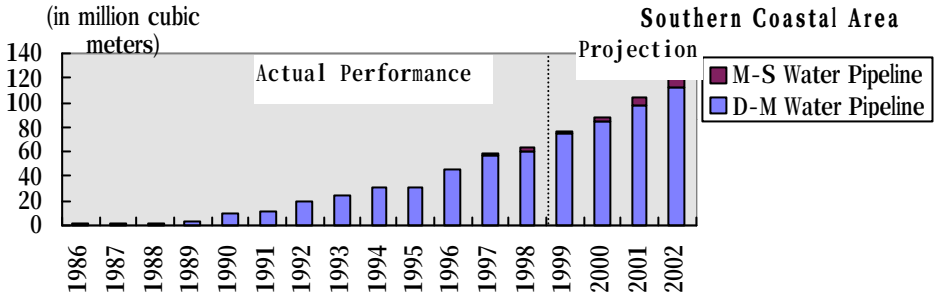
1. Water Pipeline	Steel pipe 1,600 mm×22.6 km Steel pipe 900 mm×8.3 km Steel pipe 700 mm×14.3 km	Steel pipe 1,600 mm×22.6 km Steel pipe 900 mm×8.3 km Steel pipe 700 mm×14.3 km
2. Pumping system	3 units	3 units
3. Other facilities	Administration building, etc.	Administration building, etc.
②Construction Schedule (commencement to completion)		
- ND Project	January 1990 to November 1993	September 1990 to July 1993
- N-N Water Pipeline Project	September 1993 to February 1996	April 1994 to April 1997
- M-S Water Pipeline Project	August 1989 to December 1990	July 1991 to March 1993
③Project Cost (Unit: million yen)	(Total/ODA loan portion)	(Total/ODA loan portion)
- ND Project	8,615/4,357	9,255/3,226
- N-N Water Pipeline Project	12,532/6,362	7,626/4,102
- M-S Water Pipeline Project	1,570/1,459	1,450/1,052

(4) Project Implementation Scheme: The executing agencies are RID and PWD. Both agencies have necessary experience and capability in waterworks projects, and for the projects for this evaluation, both of them generally exhibited good performances. As noted in "Implementation Schedule," however, in the case of the M-S water pipeline project, there is some room for further improvement in administrative procedure at RID.

(5) Operations and Maintenance: Operation and maintenance of Nong Pla Lai Reservoir is conducted by RID, as in the case of its construction project implementation. With regard to the water pipeline projects, their operation and maintenance, after the foundation of East Water Resources Development and Management Public Co., Ltd. (East Water) in 1992, were commissioned to East Water, the only agency responsible for supplying raw water in the Eastern Seaboard of Thailand. Initially, East Water was established as a state owned enterprise, and since then, privatized by opening 51% of the stock publicly. After being placed in operation, East Water has continued improving operation efficiency through automation, and East Water is a representative case in which privatization brought improvement in operational efficiency in water supply in Thailand.

(6) Operational Performance (See <u>Appendix 1</u> for more detailed discussion): The water transmission amount by each water pipeline is as shown in graphs below, and the data in 1999 and in the subsequent years are based upon projections by East Water.





The water transmission pipelines in the western coastal area supply industrial water mainly for Laem Chabang Industrial Estate and domestic water for Laem Chabang City and Chonburi City. The water transmission pipelines in the southern coastal area supply industrial water in Map Ta Phut Industrial Complex and domestic water in Sattahip City and Ban Chiang District. In both N-N water pipeline and M-S water pipeline, their utilization rate still remains low, because operation just started in 1998, but it is projected to grow along with the development of domestic water distribution facilities in Sattahip City, Ban Chiang District, etc. In addition, the water supply amounts from Nong Pla Lai Reservoir are shown in the table below, and as known from this table, the supply amount has grown year by year after the completion of the dam.

	Projection at appraisal (2001)	1994	1995	1996	1997
Supply amount (million m^3/year)	104	50	56	76.8	78.8

(7) Management Performance of East Water (See Appendix 2 for more detailed discussion): The financial status of East Water in charge of operation and maintenance of water transmission pipelines, recorded more than 40% net profit, and as a private company, is in a stable management.

(8) Project Effects and Impacts

(i) Quantitative Effects

(a) Water Transmission Amount: The water transmission amount achieved by five projects (in fiscal 1998) consists of 9.4 million cubic meters of industrial water and 13.7 million cubic meters of domestic water in the western coastal area, and of 58.6 million cubic meters of industrial water and 1.9 million cubic meters of domestic water in the southern coastal area. These projects have achieved their project objectives as designed in keeping up with the growing demand of waters associated with industrialization and urbanization of Eastern Seaboard.

(b) Financial Internal Rate of Return (FIRR) (See Appendix 3 for more detailed discussion): FIRR based on the actual performance is 1.9% (5.2% if the uniform rate between N-L and N-N water pipeline projects is assumed) for the western coastal area water transmission project, and 9.7% for the southern coastal area water transmission project. Furthermore, FIRR of Nong Pla Lai Reservoir project takes on 5.9%, even if the calculation assumes the benefit coming from water transmission project only.

(ii) Qualitative Effects: The five projects have played an important role in realizing industrial development of Eastern Seaboard including both Laem Chabang and Map Ta Phut areas, through stable supply of waters indispensable for the industrial development.

3. Lessons learned (See Appendix 4 for more detailed discussion)

Entrusting of the operations and maintenance for the water supply system to the private sector can lead to the efficient performance in the operation and maintenance system, if necessary preconditions are sufficiently met. These preconditions include the limitation of the contents of services entrusted, the initial arrangement of the business environment by the government, and so forth. Considering the importance of meeting these preconditions, it is necessary for the developing country's government and its executing agency to examine these preconditions sufficiently and then to determine what should be entrusted.

Eastern Seaboard Development Plan
Water Resource Development / Water Pipeline Project
Appendix 1

Operations of the reservoirs and the water pipelines

(1) Water Pipeline Project for the western coastal area of the Eastern Seaboard

The water transmission amounts by Nong Kho - Laem Chabang water pipeline are as shown in Table 1. The supply of both industrial water and domestic water in the western coastal area has grown steadily, and in fiscal 1998, the utilization of Nong Kho - Laem Chabang water pipeline recorded 97.8% of the designed capacity. To cope with the increasing demand in the future, the secondary water pipeline which parallels said pipeline was constructed by PWD and placed in operation in October 1998 by Eastern Water Resources Development and Management Public Co., Ltd (East Water).

The major consumer of industrial water from this water pipeline is Laem Chabang Industrial Estate (4.9 million m^3/year in fiscal 1998). Those of domestic water therefrom are PWA Chonburi Waterworks (5.8 million m^3/year in fiscal 1998) covering Chonburi City, the capital of Chonburi Province, and PWA Laem Chabang Waterworks (7.9 million m^3/year in fiscal 1998) covering Laem Chabang City. The water supply to these three consumers accounts for 90 % of the whole supply in fiscal 1998. Accordingly, it can be said that this water pipeline contributes to the industrial water supply for JBIC-financed Laem Chabang Industrial Estate, and to the domestic water supply for Chonburi City, one of the major cities in the Eastern Seaboard, as well as to the domestic water supply for Laem Chabang City.

In order to supply raw water to Pattaya City suffering from water shortage, the provisional Laem Chabang-Pattaya water pipeline was constructed, through which water had been temporarily transmitted to PWA Pattaya Waterworks from 1991 through 1995. Ever since 1996, however, no water has been supplied to said Waterworks because of another water source developed in the suburbs of Pattaya City.

Table 1 Water transmission amount by Nong Kho-Laem Chambang water pipeline

(Actual Performance) (million m^3/year)

Fiscal year*	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Industrial water	0.02	0.5	1.3	2.7	3.1	N.A.	5.9	6.5	8.3	7.0
Domestic water	-	4.0	3.0	3.0	2.2	N.A.	8.2	11.6	12.3	13.7
Total	0.02	4.5	4.3	5.7	5.4	9.4	14.1	18.2	20.6	20.7
Rate to capacity (%)**	0.001	21.1	20.2	26.8	25.4	44.1	66.2	85.4	96.7	97.2

(Projection by EW)

Fiscal year	99	2000	2001	2002
Industrial water	9.3	14.0	15.3	16.6
Domestic water	15.4	16.6	18.1	19.6
Total	24.7	30.6	33.3	36.2
Rate to capacity (%)**	116.0	143.7	156.3	170.0

(Source) Performance: PWD and East Water,
Projection: East Water.

* Thai fiscal year (the fiscal year used in this report is of Thai system)
(Example: 1998 = from October 1st, 1997 to September 30, 1998)

** Rate to capacity is the rate of the actual transmission amount to the designed capacity (21.3 million m^3/year). The projected transmission amount includes flows by the secondary water pipeline which was completed in October 1998.

The water transmission amount by Nong Pla Lai-Nong Kho water pipeline is shown in Table 2. The Nong Pla Lai-Nong Kho water pipeline was placed in operation just in fiscal 1998, so the water transmission amount in fiscal 1998 was no more than around 4.7% of the designed capacity. On the assumption that, of the water amount transmitted to Nong Kho - Laem Chabang pipeline, Nonco Reservoir accounts for 14.6 million m^3 on annual average (this amount is that projected at the appraisal for Nong Pla Lai - Nong Kho Water Pipeline Project, which is determined by subtracting the amount of 1.3 million m^3 discharged for maintaining the river function from the annual average supply capacity of 15.9 million m^3 of said reservoir), and the remainder (portion exceeding 14.6 million m^3) is supplied through Nong Pla Lai – Nong Kho water pipeline from Nong Pla Lai Reservoir, the water transmission amount by the water pipeline is projected to reach 59.1 % of the designed capacity in fiscal 2002.[1]

Table 2 Water transmission amount by Nong Pla Lai –Nong Kho water pipeline

(Actual Performance) (Projection by EW) (million m^3/year)

[1] In fact, the supply capacity from Nong Kho Reservoir varies according to the weather. For example, the 1998 water supply from Nong Kho Reservoir was 20.0 million m^3 per year. Considering that this report needs to make comparisons to the projected amounts at the time of the appraisal, the Nong Kho Reservoir's supply capacity was determined using the figures at that time.

Fiscal year	1998	1999	2000	2001	2002
Industrial water	2.4	5.6	9.6	13.8	17.5
Domestic water	0	0	0	0	0
Nong Kho Reservoir[1)]	0.7	10.1	16.0	18.7	21.6
Total	3.1	15.7	25.6	32.5	39.1
Rate to capacity (%)**	4.7	23.7	38.7	49.1	59.1

1) The water amount which is transmitted to Nong Kho - Laem Chabang water pipeline through Nong Kho Reservoir. With regard to the assumptions in calculating the projected transmission amounts to Nong Kho Reservoir in 1999 onward, refer to the main text.

2) Rate to capacity: value to the designed transmission capacity (66.2 million m^3/year).

In order to compare the initial demand projection and the actual transmission amount, Table 3 shows the demand projection at the appraisal, actual amounts and revised demand projection by East Water for the western coastal area in the Eastern Seaboard. The initial projections in Table 3 are those used at the time of appraising the Nong Pla Lai - Nong Kho water pipeline project, based upon the JBIC financed detailed design which was implemented prior to said project.

Table 3 Water demands in Western Coastal Area, Initial projection vs. Actual performance

(million m^3/year)

	Initial projection[1)]		Actual performance	
	2001	2011	1998	2002 (Projection by EW)
Industrial water	42.9	42.9	9.4	34.1
Laem Chabang Industrial Estate [2)]	14.0	14.0	4.9	6.9
Other industrial waters	28.9	28.9	4.5	27.2
Domestic water	33.0	24.7	13.7	19.6
Chon Buri Waterworks [3)]	14.2	0.0	5.8	8.0
Laem Chabang Waterworks	18.8	24.7	7.9	11.6
Total	75.9	67.6	23.1	53.7

Source: initial projection from JBIC, actual performance from East Water.

1) These initial projections were at the time of the appraisal of the Nong Pla Lai - Nong Kho water pipeline project.
2) Includes the water demand at Laem Chabang Commercial Port.
3) The initial projection, beside the water demands covered by said waterworks, includes the water demand at Chonburi Area. For the details, refer to the main text.

Of the industrial water transmission, the water transmission to Laem Chabang Industrial Estate is smaller than the initial projection, in spite of the estate being almost fully occupied. This is probably due to the fact that, contrary to the initial projection, most of the companies which have moved into said industrial estate are of low water-dependency type or of high-water recycling type. For other industrial waters, the water transmission amount to 2002 is assumed to be on the same level as that for 2011 in the initial projection. Consequently, looking at the trends of industrial waters in total amount, demand for 2002 projected by East Water has already reached approximately 80% of the projected level to 2011.

In the initial projection, the total industrial water demand to 2011 was assumed to be achieved in 2001. In comparison with this projection, it can be said that the actual achievement of demands have proceeded at moderate speed. The water pipelines in the western coastal area, however, are designed to accommodate the increasing demand for industrial waters in fiscal 2002 onward, and are assumed to be utilized effectively as aimed initially, in keeping up with the industrial water demand up to around 2011.

In the initial projection, it is assumed that, of the domestic water amount, the portion to be transmitted to Chonbrui Area would be supplied through the existing open channel between Nong Kho Reservoir and Bang Phra Reservoir or through a new effluent pipeline to make up for the shortage from Bang Phra Reservoir, water resource of the said area. It was also assumed that the water transmission to Chon Brui Area through the western coastal area water pipeline would be halted before 2011, taking into account the possibility of water supply to said area from the Bang Pakong Reservoir under construction in the Chachoengsao province. The column “Actual performance” in Table 3 only includes the water transmission amount to Chonburi Waterworks through Laem Chabang-Bang Phra water pipeline which was constructed by East Water, but does not include the discharge amount to Bang Phra Reserivoir from Nong Kho Reservoir, because of the limitation of available information.

To review the projection of water transmission to PWA Chonburi Waterworks in 2002 onward, the projection of said Waterworks is shown in Table 4. The East Water water pipeline is connected to the

second Bang Phra purification plant of Chonburi Waterworks, and the raw water coming from the East Water pipeline is used by this purification plant only. Chonburi Waterworks has an extension plan to accommodate the increasing demand to 2015. As its first stage, extension of the second Bang Phra purification plant is underway. The extension plan assumes the water distribution amount of 70.8 million m^3 per annum in 2015. Of this amount, water from the second Bang Phra purification plant is estimated to be 11.9 million m^3 per annum, if simply calculated according to the plant's share in the total water treatment capacity of Chonburi Waterworks. The purification plant with which East Water's pipeline is connected may continue receiving raw water from East Water (newly planned Ban Khai purification plant will be constructed, with the premise of using Bang Pakong Reservoir as water source). Therefore, 11.9 million m^3 per annum of water is projected to be transmitted to Chonburi area in 2015 via the water pipelines in the western coastal area (since the projected amount of 11.9 million m^3 per annum is distribution amount after purification, the actual raw water amount would be slightly over this amount).

Table 4 Chonburi Waterworks of PWA, Actual status vs. future plan

	Actual status (1997)	Future Plan (2015)
Population in water supply district	240,100	434,000
Population served	216,042	326,000
Service Coverage	89.9%	75.1%
Purification facility capacity (Total)	(96,000m^3/day)	(242,400m^3/day)
The first Bang Phra purification plant	72,000m^3/day	72,000m^3/day
The second Bang Phra purification plant	24,000m^3/day	40,800m^3/day
Ban Khai purification plant	-	129,600m^3/day
Average distribution amount per day	92,858m^3/day	194,000m^3/day
Distribution amount per annum	33.9 million m^3/year	70.8 million m^3/year

Source: PWA (F/S of the 6th extension plan in 1993)

Of the western coastal area's domestic water, all of the water source for Laem Chabang was assumed to come from the water pipelines in the western coastal area. To review the transmission projection to PWA's Laem Chabang Waterworks for 2002 onward, the projection by said Waterworks is given in Table 5. The Waterworks has an extension plan to accommodate the water demand to 2004, and if the goals in this plan are achieved, the distribution amount in 2004 is estimated to reach 17.6 million m^3 per annum, therefore the amount of raw water slightly exceeding this distribution amount will be transmitted by the water pipelines in the western coastal area.

Table 5 Laem Chabang Waterworks of PWA, Actual status vs. future plan

	Actual status (1997)	Future Plan (2004)
Population in water supply district	100,400	337,637
Population served	37,590	203,099
Service Coverage	37.4%	60.2%
Purification facility capacity (Total)	30,000m^3/day	62,400m^3/day
Average water supply amount per day	12,083m^3/day	48,121m^3/day
Supply amount per annum	4.4 million m^3/year	17.6 million m^3/year

Source: PWA (F/S in 1990)

According to the plans of both Chonburi and Leam Chanbang Waterworks of PWA, it is projected that the domestic water demand in the western coastal area in fiscal 2002 onward will be around 29.5 million per annum, approximately equal to the level projected at the appraisal. As in the case of

industrial water, the water pipeline project in the western coastal area also seems to be effectively utilized to cope with the domestic water demand up to around 2011 as initially aimed, although its pace is more moderate than the projection at the appraisal.

With regard to the second Bang Phra purification plant of the Chonburi Waterworks, its extension work is already implemented, while Laem Chabang Waterworks also has an extension project plan, but with no perspective for the actual implementation of the plan. In the area covered by Laem Chabang Waterworks, the distribution of the water system remains at a low level, the earlier implementation of said extension work is desired, since this facility is required to meet the local demand for domestic water.

(2) Water pipeline project in the southern coastal area

The water transmission amount through Dok Krai-Map Ta Phut water pipeline is given in Table 6. In the Map Ta Phut Area embracing heavy chemical industries, the demand for industrial water increased significantly and the actual water transmission amount to designed capacity in 1998 reached 73.8%. In order to cope with the increasing water demand in the future, East Water was constructing a water pipeline from Nong Pla Lai to Map Ta Phut at the time of the field survey in November 1998. This pipeline was scheduled to be completed in February 1999 and will parallel the existing pipeline in the Dok Krai-Map Ta Phut section.

Table 6 Water transmission amount by Dok Krai-Map Ta Phut water pipeline

(Actual Performance) (million m^3/year)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Industrial water	1.6	1.5	1.8	3.7	9.5	10.8	19.3	23.9	29.8	31.3
Domestic water	0	0	0	0	0	0	0	0	0	0.002
M-S water pipeline[1)]	-	-	-	-	-	-	-	-	-	-
Total	1.6	1.5	1.8	3.6	9.5	10.3	19.3	24.2	29.8	31.3
Rate to capacity (%)	2.0	1.8	2.1	4.4	11.6	12.6	23.5	29.5	36.3	38.2

(Actual Performance) (Projection by EW)

Year	1996	1997	1998	1999	2000	2001	2002
Industrial water	44.5	55.6	58.3	70.2	79.4	90.8	105.7
Domestic water	0.01	0.03	0.04	0.05	0.05	0.06	0.06
M-S water pipeline[1)]	0.6	1.4	2.2	3.2	4.5	6.3	6.9
Total	45.1	57.1	60.5	73.8	83.9	97.2	112.7
Rate to capacity (%)[2)]	55.0	69.6	73.8	89.5	102.3	118.5	137.4

(Source) Actual Perfromance: RID and East Water, projection: East Water

1) Portion transmitted to Map Ta Phut – Sattahip water pipeline
2) Rate to capacity: this value is to the designed flow (82.0 million m^3 per annum), but with the projected value including the ongoing Nong Pla Lai-Map Ta Phut water pipeline.

Dok Krai - Map Ta Phut water pipeline is utilized mostly for the supply of industrial water. The Map Ta Phut Industrial Estate, as the largest consumer (44.1 million m^3/year in 1998), accounts for 72.9% of the total transmission amount. Other consumers of industrial water also are firms which are located in Map Ta Phut Area. This water pipeline can be highly appreciated, because of its contribution to

raw water supply in supporting industrialization of heavy chemical.

The water transmission amount by Map Ta Phut - Sattahip water pipeline is shown in Table 7. In spite of this pipeline being completed in 1993, operation just started in fiscal 1996 for supplying raw water to Ban Chang Waterworks of PWA, because of delays in development of purification and distribution facilities in Sattahip City and Ban Chang District (PWA responsible for this project, not in the scope of the ODA loan). The utilization rate to designed capacity for the water pipeline in fiscal 1998 is 15.7%. Currently, PWA is constructing new facilities or expanding purification and distribution in Sattahip City and Ban Chang District, and both of them will be finished in 1999. PWA plans to start water distribution immediately the works are completed. Resorting to these facilities, the water transmission amount by Map Ta Phut - Sattahip water pipeline is projected to reach 49.3% of the designed capacity in 2002.

The major consumer of water from this water pipeline in 1998 is Ban Chang Waterworks of PWA (1.7 million m^3/year) which accounted approximately 80% of total water transmission amount at the said Waterworks in 1998. This water pipeline is designed mainly to keep up with domestic water demand, and the projection for 2002 by East Water predicts that Ban Chang Waterworks will occupy about 60% of the total water transmission amount(4 million m^3/year), and Sattahip Waterworks about 20% (1.5 million m^3/year).

Table 7 Water transmission amount by Map Ta Phut - Sattahip water pipeline

(Actual Performance) (Projection by EW) (million m^3/year)

Year	1996	1997	1998	1999	2000	2001	2002
Industrial water	0	0.2	0.2	0.4	0.7	0.9	0.9
Domestic water	0.6	1.2	1.9	2.8	3.9	5.4	6.0
Total	0.6	1.4	2.2	3.2	4.5	6.3	6.9
Rate to capacity (%)*	4.3	10.0	15.7	22.9	32.1	45.0	49.3

* Rate to capacity = value to designed transmission capacity (14.0 million m^3/year)
(Source) Actual performance: RID and East Water, projection: East Water

In order to compare the initial projection with the actual water transmission amounts, Table 8 shows comparisons among the demand projection at the time of the appraisal, the actual amount, and East Water's revised projection. The initial projection in the table is at the time of the appraisal of Map Ta Phut - Sattahip Water Pipeline Project, based upon the JBIC-financed detailed design which was implemented prior to said project.

Table 8 Demand for water in the southern coastal area, Initial Projection vs. Actual Performance

(million m^3/year)

	Initial projection[1)]	Actual performance	
	2001	FY 1998	FY 2002 (Projection by EW)
Industrial water	54.8	58.6	106.6
Map Ta Phut industrial complex[2)]	54.8	44.1	77.0
Other industrial water	0.0	14.5	29.6
Domestic water	14.0	1.9	6.0
Ban Chang Warterworks	2.8	1.7	4.0

Sattahip Waterworks[3)]	11.2	0.0	1.5
Other domestic water	0.0	0.3	0.5
Total	68.8	60.5	112.7

Source: initial projection; JBIC, actual performance: East Water

1) This projection is at the time of the appraisal of Map Ta Phut - Sattahip Water Pipeline Project.
2) Includes the domestic water demand for Map Ta Phut Industrial Port and Industrial Complex.
3) The initial projection includes Sattahip Port.

The water transmission to the heavy chemical industry in Map Ta Phut area already exceeded the projection for 2001 at the time of the appraisal in fiscal 1998 because of the industry's growth. Consequently, although the domestic water transmission amount is significantly less than the appraisal projection, the 1998's total amount to the southern coastal area reached the level almost equivalent to the projection for 2001 at the time of the appraisal. Furthermore, according to the East Water's projection for 2002 regarding the water transmission, the industrial water amount is estimated to be approximately double the level projected at the appraisal for 2001, and the domestic water amount is estimated to reach close to half of the projection for 2001. They sum up to the amount approximately two times the appraisal projection for 2001.

To review the projections of domestic water demand in the future, which is currently lower than the initial projection, Tables 9 and 10 show respectively the projection of Ban Chang Waterworks and that of Sattahip Waterworks.

Ban Chang Waterworks is now implementing extension of the facilities. When this extension is finished, the purification capacity will be 26,400 m^3 per day. The distribution water amount estimated by PWA to be required for Ban Chang Waterworks's service area until 2016 is 6,660 m^3 per day, and this amount is smaller than the purification capacity after extension. However, PWA plans to supply water of 12,000 m^3 per day to Map Ta Phut City from Ban Chang Waterworks in the future. If the water distribution to Map Ta Phut comes to reality, the total water transmission amount from Ban Chang Waterworks is projected to be 18,660 m^3 per day and 6.8 million m^3 per annum, and in this context, East Water will supply the raw water amounts slightly larger than these.

Table 9 PWA Ban Chang Waterworks, current situation and outlook

	Actual status (1997)	Projection (2016)
Population in service area	18,100	21,400
Population served	17,531	21,377
Service coverage	96.9%	99.9%
Purification facility capacity (Total)	5,760m^3/day[1)]	26,400 m^3/day
Average distribution amount per day	4,775m^3/day	6,660 m^3/day (18,660m^3/day[2)])
Average distribution amount per year	1.7 million m^3/year	2.4 million m^3/year (6.8 million m^3/year[2)])

Source: PWA (1994's F/S)

1) Includes the amount from a small reservoir (Ban Phai Reserivoir)in the suburbs of Ban Chang.
2) The figures in parentheses indicate the amount when the water distribution plan to Map Ta Phut is realized.

The project of a new Waterworks at Sattahip is underway to keep up with the water demand until 2016. When this project is completed, distribution capacity is estimated to be 4.2 million m^3 per annum in 2006, and 7.9 million m^3 per annum in 2016. Consequently, the raw water amount slightly over these values will be supplied through the pipeline in the southern coastal area.

Table 10 Projection for PWA Sattahip Waterworks

	Projection (2016)	
Population in service area	57,703	
Population served	57,703	
Service coverage	100.0%	
	2006	2016
Purification facility capacity (Total)	12,000m^3/day	24,000m^3/day
Average distribution amount per day	11,468m^3/day	21,768m^3/day
Average distribution amount per year	4.2 million m^3/year	7.9 million m^3/year

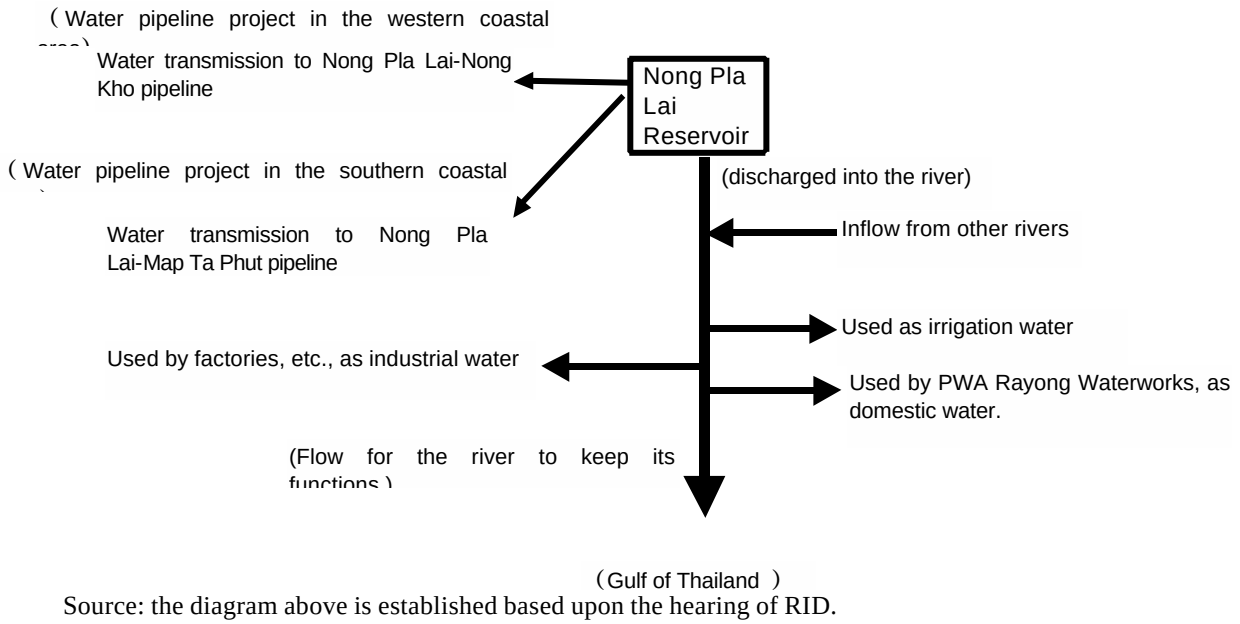
Source: PWA (1995's F/S)

The domestic water demand in the total southern coastal area is projected to be around 14.7 million m^3 per annum, including the projection of water demand beyond 2002 at Sattahip and Ban Chang Waterworkss of PWA, which is equivalent to the domestic water demand estimated at the appraisal. Due to a delay in the development of distribution facilities of Sattahip and Ban Chang Waterworks, the achievement of domestic water demand is behind the appraisal schedule, but Map Ta Phut - Sattahip water pipeline is expected to be effectively utilized along with development of distribution facilities. It is desirable that PWA completes the ongoing development of facilities at Sattahip and Ban Chang Waterworks as early as possible. Both Waterworks are also expected to implement suitable extensions responding to local needs in the future.

(3) Nong Pla Lai Reservoir

The water coming from Nong Pla Lai Reservoir, through the pipelines, is transmitted to the western and southern coastal areas for industrial and domestic waters, and discharged into the Rayong River to be used as irrigation water, industrial water, and domestic water downstream (Figure 1).

Fig.1 water supply from Nong Pla Lai



Source: the diagram above is established based upon the hearing of RID.

Table 11 shows the actual water supply from Nong Pla Lai Reservoir, which has grown year by year. At the time of the appraisal, the water supply of 104 million m^3 per annum from the reservoir is projected to accommodate the water demand in the Eastern Seaboard in 2001. The 1997 actual water amount was 78.8 million m^3 per annum, reaching approximately 76% of the appraisal projection. In 1998, operation of Nong Pla Lai - Nong Kho water pipeline started to supply water to the western coastal area. In addition, the Nong Pla Lai - Map Ta Phut water pipeline, which was under construction at the time of the ex-post evaluation field survey, is scheduled to be completed in February 1999, and after this pipeline comes fully on line, operation will be started to supply water to the southern coastal area.

The water from Nong Pla Lai Reservoir is to be used for water supply through pipelines as well as in the downstream area of the Rayong River. As shown in Figure 1, the Rayong River joins other rivers on the way and after the confluence, water is taken as irrigation, industrial and domestic waters. Therefore, concerning the consumption of the water from said reservoir in the downstream, its detailed information is unknown.

Table 11 Actual water supply from Nong Pla Lai Reservoir

(million m^3/year)

	Projection at the appraisal	1994	1995	1996	1997
Supply amount	104	50	56	76.8	78.8

Source: RID

With regard to the irrigation water, at the time of the appraisal, RID plans to include water supply not only to the existing irrigation district of Ban Khai (4,800 ha) but also that to a new extended irrigation surface of 3,600 ha. Since the water demand projection and supply plan on the whole Eastern Seaboard was reviewed, the water use of Nong Pla Lai Reservoir for irrigation was changed accordingly to supply water only to the existing irrigation district. This is because priority is given to keeping up with the water demand of industrial and domestic waters in responding to industrialization and urbanization of the Eastern Seaboard. Concerning the existing irrigation district of Ban Khai with surface of 4,800 ha, the actual irrigation area as agricultural land was 3,680 ha in 1998, and the remaining areas seem to have been converted to other uses. Considering these factors, change made by RID in the water use plan for irrigation can be judged to be appropriate.

The water supply to the extended irrigation land (the planed area was reduced to 3,200 ha) was to be made from Klong Yai Reservoir which is planned to be constructed at the east of Nong Pla Lai Reservoir (the detailed design by RID was finished in 1998). In the development of the irrigation facilities planed after completion of Klong Yai Reservoir, the irrigation plan thereof will be reviewed again in terms of scale and necessity, reflecting the situation in industrialization and urbanization of the Eastern Seaboard.

(4) Water fee, fee collection and water transmission loss

Selling rate of the raw water transmitted from East Water is shown in Table 12 (revised in October 1997). These rates can be determined independently by the East Water's Board of Directors.

East Water purchases raw water from RID at a rate of 0.5 baht per cubic meter (uniform rate

nationwide). Two kinds of water fee systems are provided, considering the fact that the rate of the water via Nong Kho - Laem Chabang pipeline is set at a lower price than other pipelines, because said pipeline needs no pumping-up with electric motor on the transmission route. Of the water transmission amount through Nong Kho-Laem Chabang water pipeline, however, the portion from Nong Pla Lai-Nong Kho water pipeline is projected to increase further, so necessity may arise that the water transmission cost through Nong Pla Lai - Laem Chabang water pipeline be revised reflecting the water transmission cost by Nong Pla Lai - Nong Kho water pipeline.

With regard to the treated water of the raw water sold by East Water, its water fee for the end users (general households, factories in the industrial complex) is 12.2 baht per cubic meter on average in the case of domestic water (the uniform rate used nationwide is set at between 7.7 and 21.0 baht.), and at a uniform rate of 14.0 baht per cubic meter in the case of industrial water which is supplied to the factories in Leam Chanbang Industrial Estate and Map Ta Phut Industrial Complex.

Table 12 Selling price of raw water by East Water

(baht/m^3)

Kind of consumer	Dok Krai-Map Ta Phut-Sattahip and Nong Pla Lai-Nong Kho	Nong-Kho-Laem Chabang
1. Domestic water (PWA)	4.00	3.00
2. Industrial water 2.1 Customers inside industrial estate	6.00	3.00
2.2 LEAT customers out of the industrial estate*	6.00	3.00
2.3 Private industrial estates	7.00	3.00
2.4 Other factories	8.00	3.00

* The factories which, though not located in the industrial complex, have continued purchasing raw water from IEAT since before the foundation of East Water.

Some customers state that collection of water fees is more stringent than in the period before the privatization of East Water (water supply is suspended immediately if the charge is unpaid ten days from due date). According to East Water, collection efficiency achieved 100 %. The water transmission loss (the portion for which fee is collected of the raw water amount sold / raw water amount purchased from RID) is now reduced to the level between 2 % (Nong Kho - Laem Chabang) and 5% (Dok Krai - Map Ta Phut - Sattahip) under the maintenance by East Water, while it was about 17% for the period where the maintenance was made by governmental agencies (PWD and IEAT). Considering the collection of charges is 100 %, the transmission loss as a whole is attributable to water leakage, and this amount is within the admissible range. According to PWA, of the 17% transmission loss before the transfer to East Water, the portion due to technical causes was 2 to 5% at the same level as now, but it is reported that there was more than 10% unpaid portion at that time when collection of fees was not as strict as by East Water. It can be said that privatization of operations and maintenance is appreciated, because it enables not only to effectively implement collection of charges and improvement of water transmission loss, but also to enhance the performance of operations and maintenance.

Management Performance of the Operations and Maintenance Agency (East Water)

The operations and maintenance of the water pipeline projects in the Eastern Seaboard were conducted separately for each of the projects: those for Nong Kho - Laem Chabang water pipeline project were by PWD which had been in charge of its construction, and those of Dok Krai - Map Ta Phut water pipeline project by its major customer, Industrial Estate Authority of Thailand (IEAT). Since East Water was founded in October 1992 in order to provide an integrated and efficient raw water supply system in the Eastern Seaboard, the management of said water pipeline projects has been commissioned to East Water[1].

Initially, East Water was established as an 100% financed affiliate of Provincial Water Authority, (hereinafter referred to as PWA), but in 1997, it became a private company by opening more than 51% of the shares (for the remaining share, 44% is owned by PWA and 5% by IEAT). The water pipelines are state-owned property, and East Water performs their operations and maintenance based upon the commissioning agreement of 30 years for the maintenance of the facilities which was concluded between East Water and the Thai Ministry of Finance. Since the agreement includes development of new facilities (water pipeline), Nong Pla Lai - Map Ta Phut water pipeline was being constructed by East Water[2] at the time of the ex-post evaluation field survey.

The background of the establishment of East Water is as follows: although the water pipelines in the Eastern Seaboard had been maintained separately by plural agencies, and as a result of the completion of Nong Pla Lai - Nong Kho water pipeline, the western and southern coastal areas in the Eastern Seaboard needed to be unified completely under a single rational and effective system. Furthermore, as part of the privatization policy by Thai government, foundation of a private company (East Water) was planned to introduce private funds in the new water pipeline projects in the Eastern region of Thailand, with expectations to raise required funds more quickly than resorting to governmental budget and to lighten the governmental financial burdens.

East Water, since its operation began, has implemented effective management through automation.

[1] Nong Pla Lai - Nong Kho water pipeline and Map Ta Phut - Sattahip water pipeline were completed after the foundation of East Water, and their maintenance has being conducted by the company, since their operation started.

[2] The service area of East Water covers the seven provinces of the Eastern Thailand, including three provinces (Chachoengsao, Chon Brui and Rayong) of Eastern Seaboard. Beside the Eastern Seaboard water pipelines, East Water plans to implement the construction and, operations and maintenance for the Chachoengsao water pipeline which comes from Bangpakong Diversion Dam. The dam is currently under construction by RID. Furthermore, the said company schemes to implement projects of same kind in Prachinburi province. East Water, in addition to JBIC-financed four water pipelines, has contracted the operations and maintenance of Laem Chabang - Pattaya pipeline, including those for the second water pipeline between Nong Kho and Laem Chabang; these two water pipelines were constructed with Thai government funds. (In 1996 onward, operation of water transmission through Laem Chabang - Pattaya has been suspended, because PWA's Pattata Waterworks can cope with the Pattaya City's domestic water demand from a water source in the suburbs of Pattaya.) East Water is constructing Laem Chabang - Bang Phra water pipeline to supply raw water to the second Bang Phra purification plant of PWA's Chon Brui Waterworks.

As of October 1998, East Water had 31 staff members at its headquarters at Bangkok, and 34 staff members (of them, 23 are operators) in total at the sites in the Eastern Seaboard. Water flow, water quality, water leakage, charges and so on were managed in real time under the centralized system, with the wireless network (a network with satellite is planned in the future) from the Rayong central control room to about 30 stations in the Eastern Seaboard (including unmanned stations). (Before the foundation of East Water, PWD's 35 members of staff and IEAT's 35 members were posted for the maintenance of Nong Kho - Laem Chabang water pipeline and Dok Krai - Map Ta Phut water pipeline.)

According to the interviews at the field survey, the salary level of employment (which is established by East Water on its initiative) is approximately two times that for the government employees in the case of management staff, and in the case of regular service staff, about 1.2 times that for government employees of the same level. With regard to the training plan, substantial curriculums are provided focusing on the technical issues such as water pumping-up and maintenance of water pipelines (in 1996, employees received training of three or four courses annually on the average per person). From these results, employment of good quality is likely to be ensured. This is a typical example demonstrating that privatization could lead to improvement of operational performance.

Table 1 shows the financial statements in fiscal 1997 of East Water (as of the end of September 1997). According to these statements, the financial conditions of East Water can be said to be stable as a private firm, recording more than 40% net profit. As note-worthy features extracted from the financial statements, East Water, because of operating the state-owned facilities on rental basis, possesses no fixed assets and does not suffer from long-term debts, since there has been no new large scale investments. A 10% dividend is given to shareholders. Therefore, East Water is an attractive investment target. As East Water needs to implement fund raising by itself for investment in the development of new equipment, however, long-term debts and fixed assets are projected to increase in the future.

The case of East Water can be said to be a typical example of PSP (Private Sector Participation) for the water pipeline projects in Thailand. The features of this example are as follows;

① The service area is an area of large water demands, that is, the East Seaboard.

② In the initial stage, operations and maintenance were implemented by the state-owned enterprise, and after confirming good potential of earning income continuously, operations and maintenance were commissioned to the private sector.

③ Originally, East Water was established as a public agency, and privatized later.

④ The privatized scope is limited to water transmission only, not including purification and distribution.

The items ② and ③ above mean that the framework enabling East Water's appropriate management was prepared beforehand with the governmental support at the stage of starting East Water's operation. As mentioned earlier, due to privatization of operations and maintenance which followed the foundation of East Water, it is possible for this private company to ensure quality labor by providing its own salary system, and to create the incentives for management improvement through introduction of share on the private capital market. As a result, positive effect on operations and maintenance, including increase in the fee collection rate and decrease in water transmission loss, can be said to be brought about.

For new water pipeline projects, East Water is now able to implement its own fund raising from private sectors, and as a result, the company will cope with fund raising on its own initiative for implementing large scale water pipeline projects. These new projects need, in completing the project successfully, Thai government's commitment in the development of water sources such as reservoirs which are not

included in East Water's scope. Whether or not the East Water can implement these new pipeline projects as desired seems to be a key factor in achieving success results of privatization of water pipeline projects in the Eastern Seaboard.

Table 1 Financial Statements of East Water (fiscal 1997)

Balance sheet (Unit: million baht)

Assets		Liabilities	
Current assets	2,387.9	Current liabilities	468.2
Cash and deposits with banks	2,279.6	Accounts payable	108.5
Account receivable-trade	55.0	Profit sharing*	4.2
Accrued income, etc	53.3	Outstanding corporation tax, etc.	91.8
		Dividend payable	100.0
Fixed assets	361.9	Advance received, etc.	163.8
Construction in progress	164.9	Fixed liabilities	8.1
Tangible fixed asset	194.0	Total of liabilities	476.4
Other	3.0	Capital	
		Capital stock	1,000.0
		Capital reserve	1,069.8
		Earned surplus reserve	28.5
		Earned surplus	175.1
		Total of liabilities	2,273.4
Total of assets	2,749.8	Total of assets and liabilities	2,749.8

Income statement (Unit: million baht)

Sales	421.6
Cost of goods sold	(198.6)
Sales profit	223.0
Selling and administrative expense	(4.3)
Profit sharing, etc*	(39.8)
Operating income	178.9
Interest earned, etc	128.1
Director's salaried and remuneration	(1.5)
Pretax current term profit	397.4
Corporation tax, etc	(135.1)
Current term profit	262.4

* Profit sharing: rental cost of facilities to be paid to Ministry of Finance

Source: Annual Report of East Water

Financial Internal Rate of Return (FIRR)

(i) Water pipeline projects

To calculate FIRR of the four JBIC financed water pipeline projects, due attention should be paid to the fact that these water pipeline projects are networked to each other both in the western coastal area and in the eastern coastal area, including other water pipelines constructed with other financial sources. Calculation of FIRR at the appraisal is shown in Table 1. As indicated therein, FIRR of the four projects was calculated with a different premise at the time of the appraisal (difference in the covering scope of benefits and expenses). For the recalculation of this time, FIRR of each network in the western and southern coastal areas is determined using the same premise (Table 2).

In calculating FIRR for this time, the growth projection of water demand in the future is based upon the projection which is described in the evaluation of operations and maintenance in this report. In other words, for Chon Brui, Laem Chabang and Sattahip Waterworks of PWA, the benefits are calculated using PWA's demand projection, and concerning domestic and industrial waters other than these, they are determined based upon the demand projection of East Water to 2002.

Table 1 Estimated FIRR at the time of the appraisal of the water pipeline projects for Eastern Seaboard Development Plan

	Water pipeline projects in the western coastal area		Water pipeline projects in the southern coastal area	
	Nong Kho-Laem Chabang (N-L) water pipeline	Nong Pla Lai-Nong Kho (N-N) water pipeline	Dok Krai-Map Ta Phut (D-M) water pipeline	Map Ta Phut-Sattahip (M-S) water pipeline
Benefits (Income from raw water sales)	N-L water pipeline only	N-N water pipeline only + N-L water pipeline	D-M water pipeline + M-S water pipeline	M-S water pipeline only
Costs (construction cost. maintenance cost)	N-L water pipeline only	N-N water pipeline only	D-M water pipeline + M-S water pipeline	Half of the cost of M-S and D-M water pipelines
Project life	20 years after operation	25 years after operation	40 years after operation	40 years after operation of D-M water pipeline
FIRR	6.7%	4.2%	5.7%	7.0%

Source: data at the JBIC's appraisal

Table 2 Recalculated FIRR for the Eastern Seaboard Development Plan's water pipeline projects

	Water pipeline projects in the western coastal area	Water pipeline projects in the southern coastal area
Benefits (Income from raw water sales)	① N-L water pipeline + N-L's secondary pipeline + N-N water pipeline + Laem Chabang-Bang Phra (L-B) water pipeline ② not includes the transmission portion to Pattaya	D-M water pipeline + M-S water pipeline + Nong Pla Lai-Map Ta Phut (N-M) water pipeline
Costs (construction cost, maintenance cost)		
Project life	40 years after operation	
FIRR	1.9% (5.2%)	9.7%

1) Since the transmission to PWA's Pattaya Waterworks is temporary, the cost and benefits for Laem Chabang-Pattaya pipeline are not included.

2) The benefit from the western coastal area for the actual portion is based upon PWD and EW's actual incomes, and that for the projection portion is estimated based upon the 1998's rate system of EW. Concerning the benefit from the southern coastal area, the benefit amount for EW is based upon EW's actual income amount, and for other actual portions and projection portions, they are estimated from 1998 water fee system of EW.

3) The maintenance cost is estimated using the maintenance unit price per $1m^3$ of transmission amount and per 1 km of water pipeline, which is calculated by dividing the amount of raw water-sales cost, selling expenses and administrative costs by the water transmission amount and the total length in kilometer of water pipelines.

4) Recalculation of FIRR is made with 1998 price.

5) Project life is 40 years after the start of operation of the water pipelines constructed the most recently among the two JBIC-financed pipelines in the western coastal area and in the southern coastal area respectively (N-N pipeline in the western coastal area and M-S pipeline in the southern coastal area) .

Concerning the recalculated FIRR of the water pipeline projects in the southern coastal area, it was estimated at 9.7%, and was higher than that at the time of the appraisal, in spite of comprising the costs for Nong Pla Lai - Map Ta Phut water pipeline project which had not been included in the FIRR at the appraisal[1]. This could be because the construction cost was less expensive than the original plan, and the industrial water demand was larger than initially projected, and because the selling price of raw water was higher than projected at the appraisal.

From this recalculation results, the water pipeline projects in the southern coastal area could be said to be an efficient investment as a whole, regardless of some delay in the realization of water demand for these pipelines.

On the other hand, the recalculated FIRR for the water pipeline projects in the western coastal area is 1.9%, smaller than that for the southern coastal area, resulting from the fact that the water transmission charges in Nong Kho - Laem Chabang is set at a lower level than other water pipeline projects. The cause of such low price in the water pipeline is that the transmission from Nong Kho reservoir needs no pumping-up with electric motor. In the future, of the raw water amount from Nong Kho - Laem Chabang pipeline, the portion from Nong Pla Lai - Nong Kho pipeline is projected to increase. Therefore, the selling charge of the raw water from Nong Kho-Laem Chabang needs to be

[1] With regard to the water pipeline projects in the southern coastal area, since the assumptions other than that for expenses are similar between the appraisal and recalculation, the comparison between them may be possible.

adjusted accordingly to reflect the pumping-up cost. With the assumption that the same water charge as that for Nong Pla Lai - Nong Kho water pipeline applies to the water transmitted from Nong Pla Lai - Nong Kho water pipeline to Nong Kho -Laem Chabang water pipeline from fiscal 2001, FIRR is 5.2%, at the same level as at the appraisal.

The appraisal premise for the western coastal area's water pipeline project is considerably different from that for the recalculation. For comparison, the FIRR recalculated using the same premise as that at the appraisal. As a result of that recalculation, FIRR for Nong Kho - Laem Chabang only is 11.9%, and FIRR for Nong Pla Lai - Nong Kho water pipeline alone takes on 2.5% (current water fee system) or 5.0% (when the same rate as that for Nong Pla Lai-Nong Kho water pipeline applies to Nong Kho-Laem Chabang water pipeline in 2001 onward)[2]. With FIRR of Nong Kho - Laem Chabang, its recalculated value is higher than the one at the appraisal. This is attributable to the following three reasons; the construction cost is smaller than initially projected; the water demand is over the appraisal projection; the raw water-selling price is higher than the appraisal projection. FIRR for Nong Pla Lai-Nong Kho water pipeline is also higher than that of the appraisal if the water pumping-up cost of the pipeline is reflected in the selling price. The major factor thereof is that the construction cost is smaller than the initial plan[3].

These results of the recalculations demonstrate that the investment in the western coastal water pipeline projects was also efficient.

(ii) Nong Pla Lai Reservoir

At the time of the appraisal for Nong Pla Lai reservoir, Economic Internal Rate of Return (EIRR) was calculated using the benefits that are given in Table 3. The EIRR was not recalculated for this evaluation because it is difficult to quantify economic benefits (reduction of damages due to floods) due to limitation of data and materials. Instead, Financial Internal Rate of Return (FIRR) is calculated using only the income from the water pipeline projects in the western and southern coastal areas as the project's benefit. This result is 6.0%, which demonstrates that even in the case of considering the incomes from the water pipeline projects only, the investment in Nong Pla Lai Reservoir could be evaluated as efficient.

Table 3 IRR of Nong Pla Lai Reservoir

	Projection (FIRR)	Performance (FIRR)

[2] FIRR-recalculation premise for Nong Kho - Laem Chabang water pipeline alone: benefits and costs for this pipeline only, excluding the transmission portion to Pattaya. The maximum transmission amount is fixed at 20 million m^3 per annum, and project life is 20 years after operation starts. FIRR-recalculation premise for Nong Pla Lai - Nong Kho water pipeline alone: benefits and costs for this pipeline only. The benefit from Nong Kho - Laem Chabang water pipeline is just the portion transmitted from Nong Pla Lai - Nong Kho water pipeline. Project life is 25 years after operation starts.

[3] At the time of appraisal for Nong Pla Lai - Nong Kho water pipeline, the raw water-selling price is calculated at 6 bahts per cubic meter for all of the transmission amounts. This price is double the current selling price for the Nong Kho - Laem Chabang water pipeline.

Benefits	① Income from raw water sales in the western coastal area (Laem Chabang, Pattaya), southern coastal area (Map Ta Phut, Sattahip) and in the Rayong river's downstream. ② Increase in the agricultural crop in the irrigation district ③ Reduction of damages resulting from inundation, because of the flood impact being alleviated.	Income from raw water sales (N-L water pipeline + N-L secondary pipeline + N-N water pipeline + L-B water pipeline + D-M water pipeline + M-S water pipeline + N-M water pipeline)
Cost	Construction cost, maintenance cost (Nong Pla Lai Reservoir + M-S water pipeline + N-N water pipeline + Laem Chabang - Pattaya water pipeline + Nong Pla Lai - Dok Krai water pipeline + Irrigation facilities + Klong Yai Reservoir)	Construction cost, maintenance cost (Nong Pla Lai reservoir + above water pipelines)
Project life	50 years after completion of reservoir	40 years after operation of the water pipeline project
IRR	8.2 %	5.9 %

Source: Projection: the JBIC's appraisal data
Performance: calculated using PWD, RID and East Water's data.

1) Calculation of FIRR at the appraisal did not include the construction cost of N-L and D-M pipelines which had been constructed prior to the construction of Nong Pla Lai Reservoir, because this cost is treated as sunk cost.
2) The project life under the column of Performance is set at 40 years after the start of the operation of JBIC-financed water pipelines to use the same premise for the pipeline projects in Table 2.

Lessons learned

Privatization of operations and maintenance of the water supply facilities is likely to bring improved performance. However, the prerequisite for this is to define which particular function should be commissioned and to set up necessary regulations and arrangements of the initial business environment by the government. It is necessary for the government of developing countries and the particular implementation agency to consider these conditions sufficiently and to decide the commissioned items.

The operations and maintenance of the Eastern Seaboard's water pipeline project has been commissioned to the private sector, and they are exhibiting good performance for the moment. From this, it is not appropriate to conclude immediately that privatization of operations is always effective. This case, however, can be said to be a typical example to make possible the private sector participation and to bring about such impacts as the improved operation and maintenance performance and the reduction in governmental financial burden in new water pipeline projects, by defining and limiting the commissioned items clearly (commissioning to the private sector was limited to the water transmission to large consumers such as industrial complexes and waterworks) and by the government's arrangement of the initial business environments needed for successful business (the water pipeline projects were privatized after they had been effectively implemented by the government to some extent).[1]

This example demonstrates that there are some cases where participation of private sectors works well as one of the means to promote efficiency of operations and maintenance of water supply facilities in developing countries. Furthermore, private sector's participation of this kind is possible in other sectors (transport sector including port, airport, railway and roads), and a lot of successful examples are already available. As mentioned above, the premise for the success is always the government's arrangement of initial business environments. Consequently, on the side of the developing country and the implementation agency, it is necessary to judge privatization feasibility by reviewing these conditions for each case and, if any, to determine what is commissioned. On the other hand, JBIC is in the position of providing support for developing countries in implementing development and operations of water supply facilities (and other sectors), and when considering the individual projects, there arise many cases in which JBIC needs to review feasibility for private sector participation, as one of the options in enhancing operational efficiency, and its conditional arrangement. In order that these supports and aids become substantial and meaningful, JBIC is expected to accumulate required knowledge by sorting and analyzing the cases (including cases of other countries and other sectors) of private participation into the water supply facilities projects, including the Eastern Seaboard's water pipeline project.

[1] As mentioned above, privatization of water pipeline projects in the Eastern Seaboard has achieved success in the operations and maintenance so far, as well as in the implementation of new water pipeline projects by the concessionaire. In the future, implementations of new projects by concessionaire's own funds are expected to increase, and the true success of this privatization depends upon whether the concessionaire can perform business well or not.