People's Republic of China

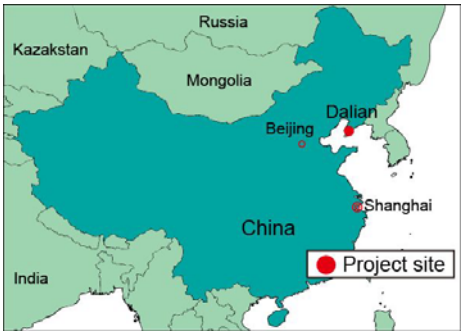
Ex-Post Evaluation of Japanese ODA Loan Project
Dalian Water Supply and Wastewater Treatment Project

Akemi Serizawa, Sanshu Engineering Consultant

0. Summary

The project, which improved the water supply facilities in Wafangdian and Zhuanghe and the wastewater treatment facilities in Wafangdian and Lushunkou in Dalian City, has been highly relevant with China's development plans, development needs, as well as Japan's ODA policy; therefore its relevance is high. The project cost was lower than planned, but the project period was substantially longer than planned because the completion of the Zhuanghe subproject was considerably delayed. Therefore, the efficiency is moderate. All subprojects have largely achieved their development objectives, which were to decrease the demand-supply gaps of water supply through the improvement of the water supply facilities or to improve the water quality of the rivers through the improvement of the wastewater treatment facilities, thus to improve the living conditions and the sanitary environment. Therefore, the effectiveness of the project is high. Since no major problems have been observed in the operation and maintenance systems such as organizational setup, technical capacity and financial status, the sustainability of the project is considered high.

1. Project Description



Location of Project Site

Lushunkou Wastewater Treatment Plant

1.1 Background

Water supply facilities in large cities of China have been improved since the 1980s. Since 1990s, suburban areas of large cities have faced to the demand-supply gap in water due to the increase of the water demand for the industrial and domestic purposes as a result of rapid industrialization and urbanization. Regional disparities of water supply services existed within a

city; while the central areas had almost achieved universal water supply, some suburban areas had only communal wells. The quantity of wastewater discharge also increased in cities due to rapid urbanization, and its average annual increase was 2.1% in China. Water pollution was also serious due to the increase of wastewater discharge.

The target areas of this project were Wafandian City, Zhuanghe City and Lushunkou District, all of which are municipalities of Dalian City. They have also experienced urbanization and thus faced insufficient water supply, increase in wastewater discharge and water pollution in the rivers.

1.2 Project Outline

The project objective is to contribute to the decrease of the demand-supply gap in water supply and to the improvement of the water quality of the rivers and thus to the improvement of the living conditions through the development of the water supply facilities in Wafangdian City and Zhuanghe City and of the wastewater treatment facilities in Wafangdian City and Lushunkou District in Dalian Metropolis. The project areas are shown in Figure 1.

Source: Wikipedia

Figure 1 Project areas (Dalian City)

Approved Amount/Disbursed Amount	3,309 million yen / 3,165 million yen
Exchange of Notes Date/Loan Agreement Date	March 2001 / March 2001
Terms and Conditions	Water supply projects: Interest rate 1.30%; Repayment period 30 years (Grace period 10 years) Conditions of procurement: General Untied Wastewater treatment projects: Interest rate: 0.75%, Repayment period 40 years (Grace period 10 years) Conditions of procurement: Bilateral-tied
Borrower/Executing Agency	Government of People's Republic of China / The People's Government of Dalian City
Final Disbursement Date	July 2006
Main Contractor (over 1 billion yen)	-
Main Consultant (over 100 million yen)	-
Relevant Studies (Feasibility Study and others)	Wafangdian Third-Phase Water Supply Project: China Northeast Design Institute (October 1998) Zhuanghe City Water Supply Project: China Huabei Design Institute (August 1998) Wafangdian Sewage Treatment Project: China Northeast Design Institute (October 1998) Lushunkou District Pollution Comprehensive Treatment Project: China Huabei Design Institute (September 1998)
Relevant Projects	JICA: Dalian Water Supply System Rehabilitation Project (L/A: September 1997) Norway and Netherland: Water supply project (Dalian Economic & Technological Development Zone) (1994) ADB : Dalian Water Supply Project (Dalian central districts) (1995) World Bank: Liaoning Environment Project (including Dalian wastewater) (1994)

2. Outline of the Evaluation Study

2.1 External Evaluator

Akemi Serizawa, Sanshu Engineering Consultant

2.2 Duration of Evaluation Study

The subject ex-post evaluation assignment was implemented as follows:

Duration of the Study : December 2010 – December 2011

Duration of the Field Study : February 20-March 5 and May 15-28, 2011

2.3 Limitation of evaluation

The subprojects are not related to each other except for the two Wafangdian projects. They are operated independently by each municipal government and its respective water supply company or wastewater treatment company, and the three target municipalities are distant from each other (100-200km in between). The government of Dalian City is not involved in the operation of the subprojects after it distributed the yen-loan funds to the three municipalities. The government of Dalian City was not able to provide the evaluator with the data of water supply and wastewater treatment of the whole Dalian City. Therefore, it was difficult to assess the synergistic effects of the subprojects and their impacts on the whole Dalian City. Considering the independent nature of each subproject, the evaluator rated them separately first and then rated the project on the whole.

3. Results of the Evaluation (Overall Rating[1]: A)

3.1 Relevance (Rating[2]: ③)

3.1.1 Relevance with the Development Plan

The 9th Five-Year Development Plan of China (1996-2000) stated that the improvement of water supply facilities in the cities in the regions was one of the most essential agenda, and set up the following targets to be achieved during the Five-Year Plan period: i) increase of nationwide water supply by 40 million m^3/day; ii) raise the water supply coverage in urban areas to 96%; and iii) increase average water supply per person by 40ℓ/day. The water supply facility capacity increased by 13.15 million m^3/day by 1998, and thus the target should have been achieved by 2000 taking into account the facilities under construction. The target of water supply coverage in urban areas had been achieved by 1998, ahead of the schedule. The average water supply per person in 1998 was 214 ℓ/day, which has exceeded the target (210 ℓ/day).

Since many areas still suffered from shortage of water, however, the improvement of water supply facilities was among the priorities in the urban development plan also in the 10th Five-Year Plan (2001-2005).

Regarding wastewater, the government established regulations of the industrial wastewater discharge including introduction of the pollution charges, environmental assessment and the "three simultaneous system" which required companies to design, construct and operate pollution-prevention facilities at the same time as the construction of the main plants. The government also prioritized the improvement of wastewater treatment facilities in urban areas to respond to the rapid increase of domestic wastewater discharge.

The 11th Five-Year Development Plan (2006-2010) of China stated that the protection of

1 Overall rating: A: "very high", B: "high", C: "low in some aspects", D: "low"
2 Rating: ③: "high", ②: "moderate", ①: "low"

water sources for urban areas was to be strengthened, and construction of water supply facilities was to be further promoted. The ongoing 12th Five-Year Development Plan (2011-2015) also promotes the improvement of basic infrastructures including water supply and wastewater treatment facilities to ensure supply of safe water and to reduce water pollution.

This project was included as one of the priority projects in the 9th and 10th Development Plans of the three target municipalities. The priority areas of their 11th and 12th Development Plans include the improvement of water supply and wastewater treatment facilities in Wafangdian, the improvement of water supply facilities in Zhuanghe and the improvement of environment in Lushunkou.

The project was in line with the national policy of China and the development plans in the target municipalities because the improvement of water supply facilities and wastewater treatment facilities were among the priority areas, both at appraisal and ex-post evaluation.

3.1.2 Relevance with the development needs

At appraisal in 1999, the water supply capacity of Wafangdian City was only 50,000m^3/day which was just the same as its water supply demand. Wafandian City had a plan to increase its water supply capacity to 100,000m^3/day by 2003 by the construction of a new water plant of 65,000m^3/day by this project, in addition to another 35,000m^3/day capacity of the existing plant, which was to be reduced from 50,000 m^3/day to improve the quality of treated water. The water supply capacity of Zhuanghe City was only 47,000m^3/day, which was less than its water demand of 54,000 m^3/day. The plan of Zhuanghe City was to increase its water supply capacity to 100,000m^3/day by 2010 by the construction of a new water plant of 50,000m^3/day by this project, followed by another plant of 50,000m^3/day capacity after closing down the existing plant. Wafangdian City and Lushunkou District had no wastewater treatment facilities at the time of appraisal. Untreated wastewater discharged to the rivers caused stench and deprived citizens of healthy living conditions. This project to improve the water supply and wastewater treatment facilities was therefore relevant to the development needs of the target municipalities.

At the time of ex-post evaluation, the water supply capacity of Wafangdian City and Zhuanghe City and the wastewater treatment capacity of Lushunkou District cover their current demands, thanks to the contribution of the project. However, the demand might overtake the supply capacity sooner or later, as the further increase of the demand is anticipated. The wastewater treatment demand of Wafangdian City has already exceeded the capacity of the plant while it was sufficient to cover the demand when the plant started operation. The details of the demand and the supply capacity of each target municipalities are shown from Table 5 to Table 8

From the above, the needs to strengthen the water supply and wastewater treatment capacities existed in the target municipalities, both at appraisal and ex-post evaluation.

3.1.3 Relevance with Japan's ODA policies

According to the Overseas Economic Cooperation Implementation Policy (issued on December 1, 1999 and valid up to March 2002), the Japanese aid policy towards China focused on alleviation of disparity between regions, particularly giving priority to inland region and the development of the economic and social infrastructure which would promote self-motivating economic development in order to promote the development of the private sector and democratic markets, and to urge the well-balanced development to promote the market-oriented economy. This project to improve water supply and wastewater treatment facilities was in line with the Japanese aid policies.

The four subprojects and therefore the project on the whole have been highly relevant to the development policies in China, development needs, as well as Japan's ODA policies, and therefore the relevance of the project is high.

3.2 Efficiency (Rating:②)

3.2.1 Project Outputs

The project outputs (planned and actual) are summarized in Table 1.

Table 1. Comparison of Project Outputs (Planned and Actual)

Sub-project	Planned	Actual
A. Wafangdian water supply	・ Water intake pipes approx. 26km ・ Pumping facility 1 set ・ Water conveyance pipes between the pump station and the water treatment plant approx. 11km ・ Water treatment plant 65,000m^3/day (coagulation-sedimentation-rapid filtration system) ・ Water distribution pipes approx.14km	As planned. ・ Water intake pipes approx. 26km ・ Pumping facility 1 set ・ Water conveyance pipes between the pump station and the water treatment plant approx. 11km ・ Water treatment plant 65,000m^3/day (coagulation-sedimentation-rapid filtration system) ・ Water distribution pipes approx.14km
B. Zhuanghe water supply	・ Water intake pipes approx. 1 km ・ Water conveyance pipes approx. 16 km ・ Water treatment plant 50,000m^3/day (coagulation-sedimentation-rapid filtration system) ・ Water transmission pipes approx. 3 km ・ Water distribution pipes approx. 43 km	The water distribution pipes were 30km longer than the plan. Other items were as planned. ・ Water intake pipes approx. 1 km ・ Water conveyance pipes approx. 16 km ・ Water treatment plant 50,000m^3/day (coagulation-sedimentation-rapid filtration system) ・ Water transmission pipes approx. 3 km ・ Water distribution pipes approx. 73 km
C. Wafangdian wastewater	・ Wastewater treatment plant 60,000m^3/day (BIOFOR system) ・ River course treatment approx. 4.5 km ・ Water drainage pipes approx. 8 km	Another wastewater treatment system was selected. Other items were as planned. ・ Wastewater treatment plant 60,000m^3/day (ICEAS system) ・ River course treatment approx. 4.5 km ・ Water drainage pipes approx. 8 km

D. Lushunkou wastewater	・ Pump stations: 9 ・ Wastewater treatment plant 30,000m^3/day (Oxidation ditch system) ・ Water drainage pipes approx. 59km in total ➢ From Lushunkou to the plant approx. 51 km ➢ In the plant approx. 4 km ➢ From the plant to the discharge point to the sea approx. 3km ➢ Discharge into the sea approx. 1km	Another wastewater treatment system was selected. Pumps and drainage pipes were increased to respond to the needs of wastewater treatment in Lushunkou Development Zone. Other items were as planned. ・ Pump stations: 14 (5 pump stations were added for Lushun Development Zone) ・ Water treatment plant 30,000m^3/day (A2O system) ・ Water drainage pipes approx. 73km in total ➢ From Lushunkou to the plant approx. 53 km ➢ In the plant approx. 4 km ➢ From the plant to the discharge point to the sea approx. 3km ➢ Discharge into the sea approx. 1km ➢ In Lushun Development Zone approx. 12 km

Source: Appraisal documents, Questionnaire responses

The planned outputs have been completed almost as planned. Revised items and the reasons for the change are as follows:

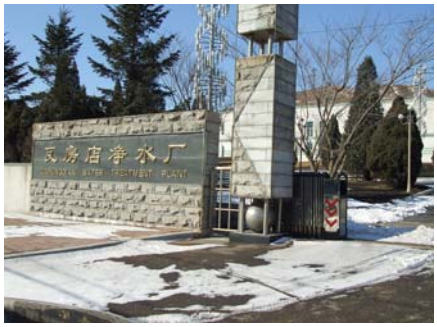
B. Zhuanghe water supply: The total extension of the distribution pipelines was about 30km longer than the plan. In order to avoid the risk of the fluctuation of the exchange rate at that time, local fund, instead of the yen-loan fund, was used to purchase the water inlet valves and chemical input facility. The surplus yen-loan fund was used to purchase the extra water distribution pipelines for the newly-added water supply areas after the appraisal.

C. Wafangdian wastewater: ICEAS[3] was selected instead of BIOFOR[4] as its wastewater treatment system. According to the executing agency, BIOFOR had become outdated and it became difficult to procure parts and materials as there were fewer manufacturers. After technical and financial comparisons between ICEAS and A2O[5], they selected ICEAS because it had advantages such as smaller operational cost.

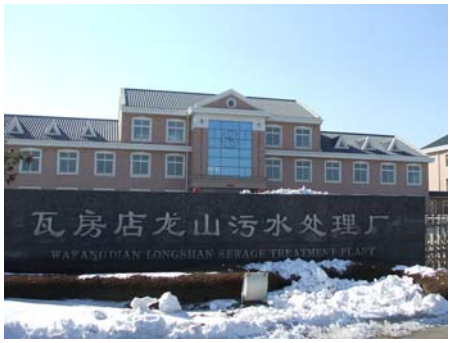
D. Lushunkou wastewater: A2O was selected instead of oxidation ditch system as its wastewater treatment system. According to the executing agency, A2O is the most popular wastewater treatment system in the Northeastern China with cold climate and

3 ICEAS (Intermittent Cycle Extended Aeration System) : One of the cyclic activated sludge technologies.
4 BIOFOR (Biological Aerated Filtration System): One of the cyclic activated sludge technologies.
5 A2O (Anaerobic-Anoxic-Oxic System): One of the cyclic activated sludge technologies.

it has various advantages such as that only one tank is needed for the three steps of wastewater treatment (adding oxygen, removing oxygen and chemical treatment), that the cost is smaller and that there is less stench. Another revision of the output was that extra pumps and water drainage pipes were procured in order to respond to the newly-developed needs of wastewater treatment in Lushunkou Development Zone.



Wafangdian Water Treatment Plant



Wafangdian Wastewater Treatment Plant

3.2.2 Project Inputs

3.2.2.1 Project Cost

The estimated project cost at appraisal was 9,235 million yen, of which the Japanese loan was to be used only for the foreign currency portion amounting to 3,309 million yen and the rest was to be financed by the Chinese government, Dalian City government and the governments of the three municipalities. The actual project cost was 9,225 million yen, of which the Japanese loan amount was 3,165million yen and the rest was financed by the Chinese government, Dalian City government and the governments of the three municipalities. The actual project cost was 100% of the plan in Japanese yen and 93% of the plan in Chinese currency. The difference between the plan and the actual cost in Chinese yuan is due to the change of the exchange rate, which was 1RMB=IJPY at appraisal and 1RMB=14JPY at ex-post evaluation. The project cost of each sub-project is summarized in Table 2.

Table 2. Project cost

	Planned	Actual	Reasons for difference	Rating
Wafangdian Water supply	1,917 million yen (FC* 985) (LC** 932)	1,851 million yen (FC 957) (LC 947)	While the outputs were same as the plan, the cost was smaller than the plan due to competitive bidding.	③ 97% of the plan
Zhuanghe water supply	1,625 million yen (FC 426) (LC 1,199)	1,157 million yen (FC 395) (LC 762)	Although the distribution pipes were 30km longer than the plan, the cost was smaller than the plan because the delivery was postponed until the exchange rate became stable and due to competitive bidding.	③ 71% of the plan
Wafangdian wastewater	1,933 million yen (FC 858) (LC 1,075)	2,588 million yen (FC 873) (LC 1,714)	The cost was larger than the plan because of the change of the wastewater treatment system that needed larger spaces for the plant.	② 134% of the plan
Lushunkou wastewater	3,192 million yen (FC 833) (LC 2,359)	3,631 million yen (FC 994) (LC 2,636)	The cost was larger the plan because the extra pumps and drainage pipes were purchased for the Lushun Development Zone. The difference of the local currency portion was due to the change of the exchange rate.	② 114% of the plan

Note: * Foreign currency, ** Local currency
Source: Appraisal documents, questionnaire responses

Zhuanghe Water Treatment Plant

Zhuwei reservoir, the source of Zhuanghe Water Purification Plant

3.2.2.2 Project Period

The actual project period substantially exceeded the planned period. The project period planned at appraisal was 31 months from March 2001 (signing of the Loan Agreement) to September 2003 (start of operation of the all sub-projects). The actual project period was from March 2001 (signing of Loan Agreement) to June 2006 (start of operation of the last subproject: Zhuanghe water supply) with a total of 64 months, which is 206% of the plan.

The delay of other three subprojects was relatively minor. Wafangdian water supply project started operation in September 2003, six months later than the plan (March 2003), Wafangdian wastewater treatment project started operation in March 2004, also six months later than the plan (September 2003), and Lushunkou wastewater treatment project started operation in January 2004, four months later than the plan (September 2003). According to the executing agencies, the reasons for the delay was the postponement of the bidding to avoid the risk of the fluctuation of exchange rate (Wafangdian water supply), the delay of the bidding for the equipment of the wastewater treatment plant following the change of the wastewater treatment method and the revision of equipment to procure (Wafangdian wastewater), and the prolonged testing process of the whole wastewater network of the district as it was their first wastewater treatment project (Lushunkou wastewater). Zhuanghe water supply project experienced significant delay: it started operation in June 2006, 33 months later than the plan (September 2003). While the water treatment plant was constructed in the planned period by the local fund as planned, the inlet pipes and distribution pipes were purchased by the Japanese loan fund about two years later than the plan, waiting for the right timing with stable exchange rate and the market prices of the steel pipes in China.

Table 3. Project period

	Planned	Actual	Project period since signing of Loan Agreement (March 2001)	Rating
Wafangdian water supply	October 2000 (start of Detailed Design) – March 2003 (start of operation)	April 2000 (start of Detailed Design) – September 2003 (start of operation)	Planned: 25 months Actual: 31 months	② 124% of the plan
Zhuanghe water supply	October 2000 (start of Detailed Design) – September 2003 (start of operation)	January 2000 (start of Detailed Design) – June 2006 (start of operation)	Planned: 31 months Actual: 64 months	① 206% of the plan
Wafangdian wastewater	October 2000 (start of Detailed Design) – September 2003 (start of operation)	January 2002 (start of Detailed Design) – March 2004 (start of operation)	Planned: 31 months Actual: 37 months	② 119% of the plan
Lushunkou wastewater	October 2000 (start of Detailed Design) – September 2003 (start of operation)	October 2000 (start of Detailed Design) – January 2004 (start of operation)	Planned: 31 months Actual: 35 months	② 113% of the plan

Source: Appraisal documents, questionnaire responses

The rating of the efficiency of the all subprojects is moderate as shown in Table 4.

Table 4. Efficiency of the sub-projects

	Efficiency (project cost and project period)
Wafangdian water supply	② (③+②)
Zhuanghe water supply	② (③+①)
Wafangdian wastewater	② (②+②)
Lushunkou wastewater	② (②+②)
Total	②

Regarding the project on the whole, the project cost was within the planned cost, but the project period was much longer than planned; therefore the efficiency is moderate.

3.3 Effectiveness (Rating: ③)

3.3.1 Quantitative effects

3.3.1.1 Results from Operation and Effect Indicators

(1) Enhancement of water supply capacity

Table 5 and 6 show the balance of water demand and supply capacity in Wafangdian and Zhuanghe respectively.

Table 5. Balance of water demand and supply capacity in Wafangdian

Year	1999	2005	2010
Population served (10,000 persons)	23.7	29.4	31.0
Water demand (10,000m^3/day)	5.0	5.0	6.7
Water supply capacity (10,000m^3/day)	5.0	10.0	10.0
Balance between demand and supply capacity (10,000m^3/day)	0	5.0	3.3

Source: Appraisal documents, questionnaire responses

Note: The current total water supply capacity of Wafangdian City is 100,000m^3/day, including the plant constructed by this project (65,000m^3/day, completed in September 2003) and the older plant, the capacity of which was decreased from 50,000m^3/day to 35,000 m^3/day to improve the quality of treated water.

Table 6. Balance of water demand and supply capacity in Zhuanghe

Year	1999	2005	2010
Population served (10,000 persons)	16.8	22.0	28.0
Water demand (10,000m^3/day)	5.4	7.8	10.0
Water supply capacity (10,000m^3/day)	4.7	4.7	10.0
Balance between demand and supply capacity (10,000m^3/day)	-0.7	-3.1	0

Source: Appraisal documents, questionnaire responses

Note: The current total water supply capacity of Zhuanghe City is 100,000m^3/day, including the plant constructed by this project (50,000m^3/day, completed in June 2006) and the new plant (50,000m^3/day, completed in April 2010 as the Phase II project of the same plant).

Wafangdian Water Treatment Plant

Water tariff of
Wafangdian Water Supply Company

Both cities have expanded the water supply capacity and the balance between the water demand and water supply capacity has been decreased. The Environment Bureaus of the two municipal governments certify that the quality of treated water satisfies the national standard of drinking water (pH, turbidity, coli form, etc.) and it is adequate as tap water. The result of the beneficiary surveys also confirmed that the water quality had been improved in taste, smell and turbidity.

(2) Enhancement of wastewater treatment capacity and decrease of pollutant discharge (decrease of water pollution)

Table 7 and 8 show the wastewater treatment capacity and the data of water quality in Wafangdian and Lushunkou.

Table 7. Wastewater treatment capacity and the data of water quality in Wafangdian

Year	1999	2005	2010
Population served (10,000 persons)	-	23.2	26.6
Wastewater treatment demand (10,000m^3/day)	5.0	6.1	10.0
Wastewater treatment capacity (10,000m^3/day)	0	6.0	6.0
Balance between demand and supply capacity (10,000m^3/day)	-5.0	0.1	-4.0
BOD of inlet wastewater (mg/L)	145	104	128
BOD of outlet treated water (mg/L)	-	10	6
BOD in the river (mg/L) Huitou River	127	2	4

Source: Appraisal documents, questionnaire responses

Note: The plant of 60,000 m^3/day capacity was the first wastewater treatment facility in Wafangdian City. At the time of appraisal, the city had a plan to increase the wastewater treatment capacity up to 100,000m^3/day by 2010, including this project, the second plant (20,000m^3/day, was to be completed in 2005) and third one (20,000m^3/day, was to be completed in 2010), which has yet been realized.

Table 8. Wastewater treatment capacity and the data of water quality in Lushunkou

Year	1999	2005	2010
Population served (10,000 persons)	-	No data	19.0
Wastewater treatment demand (10,000m^3/day)	2.9	2.0	2.9
Wastewater treatment capacity (10,000m^3/day)	0	3.0	4.0
Balance between demand and supply capacity (10,000m^3/day)	-2.9	1.0	1.1
BOD of inlet wastewater (mg/L)	170	290	151
BOD of outlet treated water (mg/L)	-	193	14
BOD in the river (mg/L) Long River	254	No data (Note 2)	No data (Note 2)

Source: Appraisal documents, questionnaire responses

Note 1: The current total wastewater treatment capacity of Lushunkou District is 40,000m^3/day, including the first plant constructed by this project (30,000m^3/day, completed in January 2004) and another plant (10,000m^3/day, completed in the end of 2010). At the time of appraisal, the District had a plan to increase the capacity up to 60,000 m^3/day by 2010, including 30,000m^3/day by this project and another 30,000m^3/day by the next plant. According to the executing agency, the District has changed the plan, and they are to add 50,000 m^3/day capacity in 2011 and 20,000m^3/day in 2012, which make 110,000 m^3/day capacity in total, as the Phase II project of the same plant.

Note 2: The water quality of the river is not measured as the treated water from this plant is discharged directly into the sea.

The wastewater treatment plants constructed by this project were the first of such facilities in the two municipalities. Before the project, non-treated wastewater was discharged directly to the rivers. As shown in the improved BOD of Huitou river in Wafangdian as well as supported by the opinions of the executing agencies and the beneficiaries, the water quality in the rivers and the sea has been improved as wastewater is properly treated. The result from the beneficiary surveys confirmed that the smells of the river and the sea had improved and the lives in the water had returned.

In Wafangdian City, the wastewater treatment capacity is not sufficient to cover the demand. According to the executing agency, the City still keeps a plan to increase the wastewater treatment capacity up to 100,000m^3/day, without detailed ideas such as the timeframe. The Lushunkou Wastewater Treatment Plant had applied the first grade wastewater treatment process since the start of operation until they upgraded the facility in 2008 by a private enterprise to conform to the second grade process, which is stricter than the first grade. It was a response to the revision of the national wastewater treatment water quality standard in 2008.

3.3.1.2. Internal Rate of Return

(1) Financial Internal Rate of Return (FIRR)

FIRRs at appraisal and at ex-post evaluation are shown in Table 9.

Table 9. FIRRs at appraisal and at ex-post evaluation

(%)

Sub-project	FIRRs at appraisal	FIRRs at ex-post evaluation
Wafangdian water supply	4.3	4.9
Zhuanghe water supply	9.8	4.4
Wafangdian wastewater	5.4	4.3
Lushunkou wastewater	2.4	2.9

Benefits: Water charge revenue
Costs: Construction costs, operation and maintenance costs, etc.
Project Life: 30 years for water supply projects; 40 years for wastewater treatment projects

The reasons for the differences between the FIRRS at appraisal and at ex-post evaluation are as follows:

A. Wafangdian water supply: FIRR at ex-post evaluation was higher than that at appraisal because the estimate of revenue in the future was based on the increase of revenue in the past, which was higher than the estimate at appraisal.
B. Zhuanghe water supply: FIRR at appraisal was based on the 50,000 m^3/day capacity of the plant constructed by the project. At ex-post evaluation, the calculation was based on the 100,000 m^3/day capacity in total, including 50,000 m^3/day of another plant that was completed in 2010. The Cost included the construction cost of the new plant and it reduced the cash flow during the period until 2010. Therefore, FIRR at ex-post evaluation was lower than that at appraisal.
C. Wafangdian wastewater treatment: FIRR at appraisal was calculated based on the assumption that the wastewater treatment capacity of the city would reach 80,000m^3/day. FIRR at ex-post evaluation was lower than that because it was based on the current capacity of 60,000m^3/day.
D. Lushunkou wastewater treatment: FIRR at ex-post evaluation was higher than that at appraisal because the actual tariff of wastewater treatment was higher than the estimate at appraisal.

3.3.2 Qualitative effects

As its qualitative effects, the project expected 1) response to the increasing water demand and 2) stable supply of safe water for the water supply projects. For the wastewater treatment projects, three effects were expected: which are 1) improvement of living conditions, 2) economy of water through the use of recycled water, and 3) recycle of sludge.

3.3.2.1 Water supply projects

(1) Response to the increasing water demand

The water supply capacity of Wafangdian is 100,000m^3/day and covers the current demand of 67,000m^3/day. The water supply capacity includes 65,000m^3/day of the plant constructed by the project, and 35,000m^3/day capacity of the older plant which was decreased from 50,000m^3/day to improve the quality of treated water. According to the executing agency, while the number of the clients has increased by about 2,000 households per year, suspension of water supply has been rare thanks to the enhanced water supply capacity.

The water supply capacity of Zhuanghe is 100,000m^3/day and is equal with the current demand of 100,000m^3/day. The capacity consists of 50,000m^3/day of the plant constructed by the project and another 50,000m^3/day of the new plant completed in April 2010. According to the executing agency, there is no plan to further increase the water supply capacity in Zhuanghe City while the supply is just the same as the demand.

(2) Stable supply of safe water

The treated water satisfies the national standard of drinking water both in Wafangdian and Zhuanghe. According to the executing agency in Zhuanghe, the water source before the completion of this project was contaminated rivers and chemical treatment was costly. After its completion, Zhuwei reservoir with excellent quality of water is used as the water source of the plant, and the cost of chemical treatment has been reduced and cleaning of tanks and pipes became less frequently needed as the water creates less sediment. Also, the level of groundwater has increased as its use has decreased, and its quality has been improved as it contains less seawater now. The improvement of water pressure through enhancement of water supply capacity allows residents of the upper floors of apartments to use tap water and toilet, while they had to often use public toilet before when the water pressure was not enough to pump up the water.

Beneficiary surveys were conducted through structured interviews in the project target areas. The number of the respondents was 200 in total, fifty for each subproject. The main findings from the surveys for the water supply projects are shown in Table 10.

Table 10. Results of beneficiary survey (water supply projects)

Changes experienced after the completion of the project	Wafangdian (Men 36, Women 14)	Zhuanghe (Men 37, Women 13)
Stable supply and safe water	96%	98%
Sufficient amount of supplied water	96%	98%
Improvement of water pressure	96%	94%
Improvement of water quality (turbidity, taste, smell)	92-94%	98%
Improvement of standard of living in sanitation	96%	98%
Reduction of time spent for housework	96%	98%
Economy of the city has been more active	96%	100%

From the above, it can be concluded that the project has been responding to the increasing water demand and contributing to the stable supply of safe water.

3.3.2.2. Wastewater treatment

(1) Improvement of living conditions

According to the executing agencies and the results of the beneficiary surveys, the living conditions along the rivers and the sea has been improved as the untreated wastewater no longer is discharged into the rivers and the sea and stench has been removed through the wastewater treatment facilities in the two municipalities. According to the executing agency of the Wafangdian wastewater treatment project, the riverside areas along Huitou River have been developed as prestigious residential areas and places for leisure, which led to the increase in the value of real property. They reported also that the fishery had been revived with return of water lives such as fish and shrimps. The executing agency of the Lushunkou wastewater treatment project also reported that the living conditions in the district had been improved by the improvement of water quality in the rivers and the sea.

(2) Economy of water through the use of recycled water

According to the executing agency of Wafangdian wastewater treatment project, the water quality of the dam of the downstream of the wastewater treatment plant has been improved, and then it is now used as a water source of tap water. In addition, 20,000m^3/day of 60,000m^3/day capacity of the plant goes through advanced treatment and is supplied as recycled wastewater (service water) that is not for human beings but for watering plants and other purposes. These facts are evidences of promotion of the effective use of the water resources.

(3) Recycle of sludge

At appraisal, sludge after wastewater treatment was to be recycled as fertilizer after

processed as determined in the national standard of sludge disposal. According to the executing agencies, however, sludge is disposed to the landfills without being recycled because the amount of sludge is small.

Table 11. Results of beneficiary survey (wastewater treatment projects)

Changes experienced after the completion of the project	Wafangdian (Men 34, Women 16)	Lushunkou (Men 39, Women 11)
Enhancement of wastewater treatment capacity	100%	100%
Wastewater treatment conditions are satisfactory.	92%	98%
Improvement of water quality in the rivers and the sea	100%	96%
Less stench of the rivers and the sea	100%	96%
Improvement of sanitary conditions	100%	98%

From the above, the wastewater treatment projects have contributed to the improvement of the living conditions and also to the economy of the water to a certain extent, while the recycle of sludge has not been in practice.

Therefore, the four subprojects, and then the project on the whole, have largely achieved the anticipated effects, and the effectiveness is high.

3.4 Impact

3.4.1 Appearance of intended impacts

(1) Contribution to the economic development in the target areas

The executing agencies reported that the project had contributed to the economic development in the target areas.

In Wafangdian City, the improvement of water supply facilities has contributed to attraction of investments. Since 2003 when the subproject was completed, two industrial zones were constructed and more than ten enterprises established offices in the city. GDP of the city has marked annual increase of more than 16%. The improvement of wastewater treatment facilities has contributed to the improvement of living conditions and to the development of the riverside as residential areas and spaces for leisure. Also, the fishery has been revived by the improvement of water quality.

Although no figures were available in Zhuanghe City, both the executing agency and the beneficiaries reported that the enhancement of the water supply capacity had contributed to the activation of the economy, as shown in Table 10 (results of the beneficiary surveys).

According to the executing agency of the Lushunkou wastewater treatment project, the plant has created employment of more than 100 people. As a result of the improvement of the living conditions, Lushunkou District has become more attractive as a tourist

destination and the value of real properties of the riverside has been increased. The fishery has been revived thanks to the return of the seashells and seaweed.

3.4.2 Other impacts (positive and negative impacts)

(1) Impacts on the natural environment

No negative impacts on the natural environment have been observed regarding the four subprojects.

A. Wafangdian water supply: The area between 1,000m upstream and 1,000m downstream of the intake spot is a reserve zone, in which no facilities or activities with a possibility of water pollution are allowed. The water quality control center (with nine staff members) conducts water quality inspections of the inlet and outlet spots of the plant. The wastewater from the plant is mainly domestic wastewater and is little polluted. After a simple treatment in the plant, it is discharged into the sewage network of the City. An automatic detection system for the chlorine leakage has been installed with an automatic absorption system. The monitoring is supervised by the Environmental Conservation Bureau of Wafangdian City and no negative environmental impacts have been observed so far.

B. Zhuanghe water supply: As the quality of the water source (Zhuwei reservoir) is good, little sludge is produced in the process of treatment. The wastewater from the plant is discharged directly to the river in the downstream. The Chemical Inspection Unit (with five staff members) conducts water quality inspections of the inlet and outlet spots of the plant. The monitoring is supervised by the Environmental Conservation Bureau of Zhuanghe City and no negative environmental impacts have been observed so far.

C. Wafangdian wastewater: It takes various measures to reduce stench. Sludge is not kept for a long time before transported to the landfill; the landfill to dispose sludge is distant from the residential areas; and the ICEAS system also is good to reduce the stench. The wastewater treatment plant itself is located in distance from the residential areas, and the site is with many greens and equipped with soundproof devices. Wastewater after treatment is checked every day by the inspection unit of the plant on the eight pollution indicators, and also receives monthly inspection by the Environmental Monitoring Station of Wafangdian City. No negative environmental impacts have been observed so far.

D. Lushunkou wastewater treatment: It takes similar measures as Wafangdian to reduce stench and the environment of the plant is also the same. Water quality inspection also follows a similar system to Wafangdian. Wastewater after treatment is checked every

day by the inspection unit (two staff members), and also receives monthly inspection by the Environmental Monitoring Station of Lushunkou District. No negative environmental impacts have been observed so far.

(2) Resettlement and Land Acquisition

The details of resettlement and land acquisition of each subproject are shown in table 12.

Table 12. Land area acquired, cost for land acquisition, resettlement and compensation

	Land area acquired	Number of resettled population	Cost for land acquisition	Compensation for resettlement
Wafangdian water supply	None	None	None	None
Zhuanghe water supply	3ha	6 people	None	RMB 320,000
Wafangdian wastewater	11ha	None	RMB 4,800,000	None
Lushunkou wastewater	5ha	None	RMB 25,570,000	None
Total	19ha	6 people	RMB 30,520,000	RMB 320,000

Source: Questionnaire responses

One household with six family members was resettled when the distribution pipes were laid out in the Zhuanghe water supply project. The executing agency reported that the compensation was made properly according to the compensation standards of the similar projects in the past in Dalian City. Regarding the wastewater treatment project in Wafandian and Lushunkou, the executing agencies reported that there had been no problems with the people affected as the land acquisition was implemented properly according to the land acquisition plans and the process of the explanation and obtaining consents was properly executed.

From the above, the project has contributed to the improvement of the living conditions and the economic development in the target areas.

3.5 Sustainability (Rating: ③)

3.5.1 Structural aspects of operation and maintenance

The following entities[6] which were identified at the appraisal stage are currently responsible for operation and maintenance of the facilities constructed by the project:

- ➢ Wafangdian Water Supply Company: 101 staff members are responsible for the operation and maintenance of the water treatment plant.
- ➢ Zhuanghe Water Supply Company: 52 staff members are responsible for the operation and maintenance of the water treatment plant.

6 The four entities are public corporations under the respective municipality government.

- ➢ Wafangdian Longshan Wastewater Treatment Plant: 28 staff members are responsible for the operation and maintenance of the wastewater treatment plant.
- ➢ Lushunkou Wastewater Treatment Plant: 28 staff members are responsible for the operation and maintenance of the wastewater treatment plant.

3.5.2 Technical aspects of operation and maintenance

The technical aspects of the four entities are as follows:

A. Wafangdian Water Supply Company: Among 101 staff members in the plant, 19 are graduates of technical colleges or above. All staff members participate in the annual technical training in quality management and process of operation and maintenance and take exams to measure achievements. According to the company, the staff members are technically capable enough to conduct standard operation and maintenance of water treatment plants. They have a management manual to ensure safety, which consist of a part for the regulations of safe productions and another for the regulations of safe operations. It includes regulations of operation and maintenance of every machine and facility.

B. Zhuanghe Water Supply Company: All of 52 operation and maintenance staff members are graduates of technical colleges or above, of which 12 are engineers or technicians. They receive annual training on procedures of operation and maintenance of equipment, among other subjects. The company has several manuals of patrol inspections and regulations for handling dangerous objects, as well as work manuals for each unit and equipment and standard of operations.

C. Wafangdian Longshan Wastewater Treatment Plant: According to the plant, the technical level of the staff members is sufficient. They participate in the monthly internal technical training. Staff members visit other wastewater treatment plants in the country once a year for technical exchanges and exchanges of views. When the plant started operation, staff members were sent to other plants in Kunming and Tsintao to be trained in ICEAS system. External experts were also invited to the plant as trainers.

D. Lushunkou Wastewater Treatment Plant: All of 23 staff members responsible for operation and maintenance have national qualifications and job experiences of at least three years, among which eight are university graduates. The plant provides technical training for newly recruited staff and all staff members participate in training in wastewater treatment technology and operation and maintenance of equipment, among other subjects. When the plant started operation, staff members were sent to other plants in Chanchung, etc. to be trained in A2O system.

3.5.3 Financial aspects of operation and maintenance

The revenue and expenditures of each entity are shown in the following tables.

Table 13. Revenue and expenditures of Wafangdian Water Supply Company

Unit: million yuan

Item	2007	2008	2009	2010
Annual sales (total revenue)	28.31	18.79	18.46	21.60
Expenditures	6.89	7.83	7.75	8.30
Cost for operation and maintenance	25.93	28.07	28.71	30.38
Operational profit/loss	-12.04	-12.61	-11.96	-8.76

Source: Executing agency

Table 14. Revenue and expenditures of Wafangdian Wastewater Treatment Plant

Unit: million yuan

Item	2007	2008	2009	2010
Annual sales (total revenue)	7.59	7.39	7.51	7.55
Cost of sales	12.13	11.82	12.10	11.56
Other expenses (including cost for operation and maintenance)	0.97	1.06	0.92	1.03
Operational profit/loss	-5.48	-5.47	-5.52	-5.04

Source: Executing agency

Table 15. Water tariff of Wafangdian City

Unit: yuan/m^3

Category	Water supply	Wastewater treatment	Total
Domestic use	1.5	0.6	2.1
Industry	3.2	0.9	4.1
Commercial	4.7	0.9	5.6
Public baths	6.0	1.1	7.1

Source: Executing agency

Table 16. Revenue and expenditures of Zhuanghe Water Supply Company

Unit: yuan/m^3

Item	2007	2008	2009	2010
Annual sales (total revenue)	34.63	35.67	37.44	45.67
Cost of sales	23.59	24.99	26.35	33.26
Other expenses	9.31	7.60	9.48	9.76
cost for operation and maintenance	8.31	6.07	8.23	8.78
Operational profit/loss	1.51	1.57	1.55	2.42

Source: Executing agency

Table 17. Water tariff of Zhuanghe City

Unit: yuan/m^3

Category	Water supply	Wastewater treatment	Total
Domestic use	1.6	0.6	2.2
Industry	3.2	0.9	4.1
Commercial	5.0	0.9	5.9
Special sector (public baths, etc.)	15.0	1.1	16.1

Source: Executing agency

Table 18. Revenue and expenditures of Lushunkou Wastewater Treatment Plant

Unit: yuan/m^3

Item	2007	2008	2009	2010
Annual sales (total revenue)	7.54	10.30	12.02	12.55
Cost of sales and other expenses (including cost for operation and maintenance)	8.64	10.10	10.14	12.57
Operational profit/loss	-1.10	0.20	1.88	-0.02

Source: Executing agency

Table 19. Water tariff of Lushunkou District

Unit: yuan/m^3

Category	Water supply	Wastewater treatment	Total
Domestic use	2.3	0.6	2.9
Industry	3.2	0.9	4.1
Commercial	5.0	0.9	5.9
Special sector (public baths, etc.)	5.0	0.9	5.9

Source: Executing agency

Among the four projects, only the financial status of Zhuanghe Water Supply Company is in surplus and others are in deficit. Since the profitability of water supply and wastewater treatment business is low, they have been run as public business. The four water supply/wastewater treatment companies are owned by the respective municipal government. The water tariff, which is the most essential factor for the profitability of the water business, is determined by the Price Regulation Bureaus of the municipal governments taking into account the financial status of the water companies, the price escalation rates and the level of the other public utility charges. When the financial status of the water companies is worsened, the municipal governments are supposed to provide the subsidy. Therefore, the financial status of the water companies are considered stable and no major issues exist in the financial sustainability of the project. The executing agencies consider that the budget for operation and maintenance of their water companies are appropriate.

3.5.4 Current status of operation and maintenance

All equipment and facilities installed or constructed by the project have been functioning well and no major issues have been reported. All water companies prepare annual plans for repair and operation and maintenance, and they operate daily inspections as well as periodic inspections every several months. Minor troubles are taken care in several days and major ones are treated according to the annual repair plan.

From the above, no major problems have been observed in the operation and maintenance of the four subprojects and therefore the project on the whole in the aspects of organizational setup, technical capacity and financial status. Therefore, the sustainability of the project is high.

4. Conclusions, Lessons Learned and Recommendations

4.1 Conclusions

Since the four subprojects are not related to each other as stated in "2.3 Limitation of Evaluation", each of them is rated first and then the project on the whole is rated. The results are shown in Table 20.

Table 20. Rating of the subprojects and the project on the whole

	Relevance	Effectiveness and Impact	Efficiency (Project Cost + Project Period)	Sustainability	Total
Wafangdian water supply	③	③	② (③+②)	③	A
Zhuanghe water supply	③	③	② (③+①)	③	A
Wafangdian wastewater	③	③	② (②+②)	③	A
Lushunkou wastewater	③	③	② (②+②)	③	A
Total	③	③	②	③	A

All subprojects and therefore the project on the whole have been highly relevant with China's development plans, development needs, as well as Japan's ODA policy; therefore its relevance is high. The total project cost was lower than planned, but the project period was substantially longer than planned because the completion of the Zhuanghe sub-project was considerably delayed. Therefore, the efficiency of the project is moderate. All sub-projects have largely achieved its development objectives, which were to decrease the demand-supply gaps of water supply through improvement of the water supply facilities or improve water quality of rivers through improvement of wastewater treatment facilities, thus to improve living conditions and sanitary environment. Therefore, the effectiveness of the project is high. Since no major problems have been observed in the operation and maintenance system of the four subprojects

such as organizational setup, technical capacity and financial status, the sustainability of the project is considered high.

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

4.2 Recommendations

4.2.1 Recommendations to the executing agencies

1) No financial problem is observed in the management of the executing agencies because the municipal governments of Dalian City determine water charges and they provide subsidies to the executing agencies when their financial status is in deficit. However, it is recommended to the municipal governments and the executing agencies to have regular discussions and consider possibilities of revision of water charges when necessary.
2) In Wafangdian City, the current wastewater treatment capacity is not sufficient to cover the demand. It is recommended to Wafangdian municipal government to prepare a concrete plan for enhancement of wastewater treatment capacity including the timeframes, while they have a plan with no determined target years or process.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

None.

Comparisons of the Planned and Actual Scope of the Project

Item	Planned	Actual
① Outputs		
A. Wafangdian water supply		As planned.
	・ Water intake pipes approx. 26km	・ Water intake pipes approx. 26km
	・ Pumping facility 1 set	・ Pumping facility 1 set
	・ Water conveyance pipes between the pump station and the water treatment plant approx. 11km	・ Water conveyance pipes between the pump station and the water treatment plant approx. 11km
	・ Water treatment plant 65,000m^3/day (coagulation-sedimentation-rapid filtration system)	・ Water treatment plant 65,000m^3/day (coagulation-sedimentation-rapid filtration system)
	・ Water distribution pipes approx.14km	・ Water distribution pipes approx.14km
B. Zhuanghe water supply		The water distribution pipes were 30km longer than the plan. Other items were as planned.
	・ Water intake pipes approx. 1 km	・ Water intake pipes approx. 1 km
	・ Water conveyance pipes approx. 16 km	・ Water conveyance pipes approx. 16 km
	・ Water treatment plant 50,000m^3/day (coagulation-sedimentation-rapid filtration system)	・ Water treatment plant 50,000m^3/day (coagulation-sedimentation-rapid filtration system)
	・ Water transmission pipes approx. 3 km	・ Water transmission pipes approx. 3 km
	・ Water distribution pipes approx. 43 km	・ Water distribution pipes approx. 73 km
C. Wafangdian wastewater treatment		ICEAS system was selected instead of BIOFOR. Other items were as planned.
	・ Wastewater treatment plant 60,000m^3/day (BIOFOR system)	・ Wastewater treatment plant 60,000m^3/day (ICEAS system)
	・ River course treatment approx. 4.5 km	・ River course treatment approx. 4.5 km
	・ Water drainage pipes approx. 8 km	・ Water drainage pipes approx. 8 km
D. Lushunkou wastewater treatment		A2O system was selected instead of oxidation ditch system. Pumps and drainage pipes increased to respond to the needs of wastewater treatment in Lushunkou Development Zone. Other items were as planned.
	・ Pump stations: 9	・ Pump stations: 14 (5 pump stations were added for Lushun Development Zone)
	・ Wastewater treatment plant 30,000 m^3/day (Oxidation ditch system)	・ Water treatment plant 30,000m^3/day (A2O system)
	・ Water drainage pipes approx. 59km in total	・ Water drainage pipes approx. 73km in total
	➢ From Lushunkou to the plant approx. 51 km	➢ From Lushunkou to the plant approx. 53 km
	➢ In the plant approx. 4 km	➢ In the plant approx. 4 km
	➢ From the plant to the discharge point to the sea approx. 3km	➢ From the plant to the discharge point to the sea approx. 3km
	➢ Discharge into the sea approx. 1km	➢ Discharge into the sea approx. 1km
		➢ In Lushun Development Zone approx. 12 km
② Project Period	March 2001 (L/A)- September 2003 (start of operation of all subprojects) (31 months)	March 2001 (L/A)- June 2006 (start of operation of all subprojects) (64 months)
③ Project Cost		
Foreign currency	3,309 million yen	3,165 million yen
Local currency	5,925 million yen (456 million yuan)	6,060 million yen (433 million yuan)
Total	9,235 million yen	9,225 million yen
Yen loan portion	3,309 million yen	3,165 million yen
Exchange rate	1 yuan=13 yen (as of March 2001)	1 yuan=14 yen (average of 2001-2006)