People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Chongqing Environment Improvement Project"

External Evaluator: Junko Miura, Global Link Management, Inc.

0. Summary

The Government of China and the Chongqing Municipal People's Government (CMPG) gave priorities to water pollution control of Yangtze River and its tributary, Jialing River, and have undertaken various actions. This project was implemented as a part of such efforts. In Chongqing City, due to rapid urbanization and industrialization, domestic and industrial wastewater increased, thus water contamination was worsened. In addition, as the Three Gorges Reservoir is located in the downstream of Yangtze River, it was urgent and highly necessary to improve the water quality of the rivers by constructing wastewater treatment facilities. The following expected effects have been observed almost as planned: the increase of wastewater treatment capacity, reduction in pollutants emission, improvement of quality of treated water, improvement of water quality of the rivers in the city. These effects have been contributing to the enhancement of the living standards of the residents along the rivers. Therefore, the effectiveness and impact is high. Although the project cost was within the plan, the project period exceeded the plan, therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

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

1. Project Description

Project Location

Jiguanshi Wastewater Treatment Plant
Digestion Tank

1.1 Background

In China, due to rapid urbanization and industrialization and the improvement of living standards since 1980's, domestic and industrial wastewater increased drastically. The wastewater treatment ratio in metropolitan cities in 2000 remained as low as at 34.3%. In addition, in the seven major river basins (Wai, Liao, Hai, Songhua, Huang, Zhu and Yangtze Rivers), the monitoring sections which did not reach Class III of the National Surface Water Quality Standards[1] (the level which can be used as source of water for drinking)[2] stood at 42.3% in 2000.

The City of Chongqing is the central city of economy, transportation and trade in the upper stream of Yangtze River. It became a government-ruled municipality[3] in 1997. Due to rapid expansion of the city central areas due to population growth and development of manufacturing industry, domestic and industrial wastewater increased. It reached 856,000 m^3/day in 2001. On the contrary, Tangjiaqiao wastewater treatment plant (WWTP) with a capacity of 48,000 m^3/day, was single WWTP in Chongqing City. The wastewater treatment ratio in the urban area of Chongqing City was extremely as low as 6%. As a result, untreated wastewater was directly flown into the rivers in the City, and the water quality of Jialing River was Class IV of the National Environmental Quality Standards for Surface Water. Under this circumstance, it was urgently needed to construct WWTPs in the City.

1.2 Project Outline

The objective of this project is to improve the water quality of rivers in the City of Chongqing by constructing WWTPs (secondary treatment facilities in Tangjiatuo and Jiguanshi), thereby contributing to the improvement of living environment of the City. The location of the project site is shown in Figure 1.

---

1 The National Environmental Quality Standards for Surface Water (GB3838-1988) categorized thirty water quality parameters from Class I to Class V. The standards were revised in 2002. The current standards (GB3838-2002) categorize twenty four parameters.

2 Similar to Japan, the water quality standards in China are regulated by the utilization purpose of the water area and by its protection purpose. Class I-III water is appropriate water for drinking. If the water quality does not meet Class V standards, it is called as "below Class V".

3 The central government administers these municipalities directly and these municipalities are the same administrative units as provinces. These include Beijing, Shanghai, Tianjin and Chongqing.

Figure 1 Location of Project Site

Approved Amount / Disbursed Amount	9,017million yen / 9,017million yen
Exchange of Notes Date / Loan Agreement Signing Date	March, 2002 / March 2002
Terms and Conditions	Interest Rate: 0.75%; Repayment Period: 40years (Grace Period: 10 years); Conditions for Procurement: Bilateral Tied
Borrower / Executing Agency	The Government of the People's Republic of China / Chongqing Municipal People's Government
Final Disbursement Date	July 2009
Main Contractor (Over 1 billion yen)	China Construction Seventh Engineering Bureau, Ebara Corporation (Japan), Chongqing Chuanyi Automation, Co., Ltd., Biwater Man Lee Limited., Tianjin Machinery & Electric Equipment Import and Export Co., Ltd.
Main Consultant (Over 100 million yen)	NJS Consultants (Japan)
Feasibility Studies, etc.	Tangjiatuo Wastewater Treatment Plant (WWTP): F/S by Central and Northern China Municipal Engineering Design and Research Institute, July 2001, Jiguanshi WWTP: F/S by Shanghai Municipal Engineering Design and Research Institute, July 2001.
Related Projects	In the late 1990's, the project preparation study including the revision of the wastewater master plan was conducted by using the grant aid by Japan, France, UK, Australia, Italy and Switzerland. The primary treatment facility and wastewater pipes of Tangjiatuo and Jiguanshi WWTPs were constructed as the first stage construction under the loan by the World Bank. The secondary treatment facility and the sludge treatment facility were constructed as the second stage construction under this project.

2. Outline of the Evaluation Study

2.1 External Evaluator

Junko Miura, Global Link Management

2.2 Duration of Evaluation Study

Duration of the Study: August, 2011 to September, 2012

Duration of the Field Study: November 13th to 26th, 2011 and March 5th to 15th, 2012

2.3 Constraints during the Evaluation Study

The primary treatment facility and wastewater pipes of Tangjiatuo and Jiguanshi WWTPs were constructed as the first stage under the loan from the World Bank, and the secondary treatment facility and the sludge treatment facility were constructed as the second stage under this project. It is considered that the above two projects and continuous efforts for improving water quality of rivers by the CMPG jointly resulted in the observed effects. Thus, it was difficult to strictly distinguish the effect by this project and the effect by other interventions.

3. Results of the Evaluation (Overall Rating: A[4])

3.1 Relevance (Rating: ③[5])

3.1.1 Relevance with the Development Policy of China

At the time of appraisal (2002), China's 10th Five-Year Environment Protection Plan (2001-2005) set the following specific objectives: decrease in the major pollutants emission by 10% compared against 2000; raise wastewater treatment ratio in urban areas to 45% (60% in the cities with a population of more than 500,000); and improve water quality in major rivers such as Yangtze, Huang and Songhua Rivers.

Chongqing's 10th Five-Year Environment Protection Plan (2001-2005) set a goal of achieving 60% of wastewater treatment ratio in the urban areas in the City and announced further promoting pollution control of wastewater. In addition, the wastewater master plan towards 2020, which was formulated in 2001, planned developing wastewater pipes and 11 WWTPs and gave a highest priority to this project among the WWTP construction projects. As shown in the table below, the facility capacity under this project occupied 84% of the overall plan towards 2010 and 62% of the overall plan towards 2020.

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, and D: Unsatisfactory.

[5] ③: High, ②: Fair, and ①:Low.

Table 1 Summary of Wastewater Treatment Master Plan

Unit: ten thousand m^3/day

Wastewater Treatment Plant	Until 2010		Until 2020	
	Capacity	Target Year	Capacity	Target Year
Tangjiatuo (This Project)	30	2005	10	2013
Jiguanshi (This Project)	60	2005	20	2013
Qiezixi	5	2007	3.1	2013
Lijiatuo	5	2007	4	2013
Zhongliangshan	5	2010	2	2013
Jinkou	2	2010	0	
Sub-total	107		39.1	
Total			146.1	

Source: JICA appraisal documents

The 11th Five-Year National Conservation Plan (2006-2010) targeted raising wastewater treatment ratio in urban areas to 70% and decreasing the emission of Chemical Oxygen Demand[6] (COD) by 10%. The current 12th National Conservation Plan (2011-2015) set the following objectives: raise wastewater treatment ratio in urban areas to 85%; decrease in the emission of COD by 8%; and decrease in the emission of ammonia nitrogen by 10%.

In the 11th Chongqing Conservation Five-Year Plan (2006-2010), priority was given to the treatment of wastewater and waste proposal. The objective of the plan was to construct 21 WWTPs in the Yangtze River Basin in order to improve the water quality of the Three Gorges Reservoir[7], which is located at the downstream of Chongqing City[8]. The current 12th Five-Year Plan (2011-2015) targeted achieving 95% of the wastewater treatment ratio in the urban areas and achieving 90% of the wastewater treatment ratio in the whole City of Chongqing. Furthermore, the plan is also to promote appropriate processing of sludge in order to achieve the goals of detoxifying and recycling the sludge which is emitted from WWTPs. The locations of Yangtze and Jialing Rivers and the Three Gorges Reservoir are shown in Figure 2.

[6] COD is the indicator which shows the degree of water contamination. It indicates the oxygen amount which is required when organic matters are treated with an oxidizing agent.

[7] The distance between the central area of the City of Chongqing and the Three Gorge Reservoir is approximately 680km.

[8] At the time of the implementation of the Three Gorge Project in 2003, it was anticipated that the self-cleansing capacity of the Three Gorge Reservoir would decrease and that the water quality of the Three Gorge Reservoir would decrease if wastewater is not treated properly in the upper stream. It was also urgently needed to improve water quality of Yangtze and Jialing Rivers in order to secure water sources for the residents around the Three Gorge Reservoir. Source: Project Completion Report (PCR).

Figure 2 Map of the Chongqing City and surrounding areas (Yangtze and Jialing River Basin)

3.1.2 Relevance with the Development Needs of China

At the time of appraisal, in the urban areas of Chongqing City (175km^2, population of 2,400,000), due to rapid urbanization, population growth and development of manufacturing industry, the domestic and industrial wastewater increased rapidly to the total of 856,000 ton/day in 2001. On the contrary, there was only one Tangjiaqiao WWTP with the treatment capacity of 48,000 ton/day. Waste water treatment ratio in the urban area was extremely as low as 6%. Because waste water was released into the rivers directly, the water quality of the Jialing River was Class IV according to the National Environmental Water Quality Standards for Surface Water, which means that the water did not meet the standards as water source for drinking.

At the time of ex-post evaluation, due to urbanization, population growth, industrialization and the development of sightseeing industry, the demand for wastewater treatment is increasing. Both WWTPs under this project are operating to those maximum capacities. Currently, based on the master plan for wastewater treatment, the third stage construction of the two WWTPs is being implemented; thus the daily treatment capacity of 100,000 tons for Tangjiatuo and that of 200,000 tons for Jiguanshi will be expanded.

Based on the facts that Yangtze and Jialing Rivers are single water sources and receiving points for treated wastewater, and that wastewater treatment in Chongqing City plays important roles in the protection of water environment of the Three Gorge Reservoir, environmental protection by wastewater treatment is continuously urgent issue.

3.1.3 Relevance with Japan's ODA Policy

The Economic Cooperation Plan towards China of the Government of Japan gave priorities to environment issues, poverty reduction and social development in inland areas, institutional formulation, and technical transfer. Among them, the cooperation for responding to global issues such as environmental issues was one of the top priorities. In addition, the Overseas Economic Cooperation Implementation Policy of Japan International Cooperation Agency (JICA, former JBIC) issued in 1999 identified environmental issues as one of the three top priorities for the loan projects for China. The country-wise Implementation Policy for China was also to consider the construction of wastewater treatment facilities and the public projects for water-saving and water resource recycling as priority issues.

In light of the above, this project has been highly relevant with the development plans of China and of CMPG, development needs, as well as Japan's ODA policies, therefore its relevance is high.

3.2 Effectiveness (Rating:③)

3.2.1 Quantitative Effects

3.2.1.1 Operation and Effect Indicators

(1) Improvement of wastewater treatment capacity

The planned and actual wastewater treatment capacity of Tangjiatuo and Jiguanshi WWTPs is summarized in Table 2. Wastewater treatment capacity achieved 90,000 ton/day as planned.

Table 2 Wastewater treatment capacity (Plan/Actual)

Unit: ten thousand m^3/day

Indicators	Plan after the project completion (2005)	Actual after the project completion (2007)
Tangjiatuo WWTP	30	30
Jiguanshi WWTP	60	60
Total	90	90

Source: Planned figures from the appraisal documents. Actual figures from the questionnaire answer of Chongqing Drainage Company (CDC).

Table 3 summarized wastewater treatment amount[9] and facility operation ratio[10] as the indicators showing whether the wastewater treatment facilities are fully operating. Since the project completion in 2007, both wastewater treatment amount and facility operation

[9] The wastewater amount which WWTPs receive and process.
[10] Daily average treatment amount/ treatment capacity.

ratio are rising steadily and the facility operation ratio keeps more than 80% every year, thus it can be said that the facilities have been used effectively. As mentioned earlier, the third stage construction are undergoing at both WWTPs in response to the increasing wastewater amount in Chongqing City.

Table 3 Daily average wastewater treatment amount and facility operating ratio

Unit (excluding treatment ratio): ten thousand m^3/day

WWTPs	2007		2008		2009		2010		2011		Facility Capacity
	Amount	Ratio	Amount	Ratio	Amount	Ratio	Amount	Ratio	Amount	Ratio	
Tangjiatuo	23.1	77%	24.1	80%	23.3	78%	25.9	86%	26.5	88%	30
Jiguanshi	47.2	79%	57.3	96%	58.6	98%	61.5	103%	64.0	107%	60
Total	70.3		81.4		81.9		87.4		90.5		90

Source: Questionnaire Answer from CDC

(2) Wastewater treatment ratio in the urban areas in Chongqing City

Table 4 shows the baseline and planned figures of wastewater treatment in the urban areas in Chongqing City. According to the Chongqing Environment Protection Bureau (CEPB), actual data of treatment ratio of whole wastewater and industrial wastewater in the urban areas were not available; however, the domestic wastewater treatment ratio in the urban areas in 2011 was approximately 95%. Therefore, as far as domestic wastewater treatment ratio in the urban areas, it can be said to have achieved its target. Regarding the industrial wastewater, the CEPB explained that a number of factories discharge wastewater into the rivers after treating wastewater by their own facilities, and that the strict emission standards were established.

Table 4 Wastewater treatment ratio in the urban areas in Chongqing City

Unit: %

Indicator	Baseline (2001)	Plan (2005 and 2010)	Actual (2011)
Wastewater Treatment Ratio	6	95	Domestic wastewater: 95 Total and industrial wastewater: Unknown

Source: Baseline and planned figures from JICA appraisal documents. Actuals from the interview with the CEPB.
Note: Wastewater treatment ratio= wastewater treatment amount / total wastewater.

The target wastewater treatment ratio in the urban areas in Chongqing City has been achieved not only by this project; however, based on the fact that the treatment capacity of facilities under this project occupied 84% of the overall wastewater treatment plan towards 2010, it can be considered that this project has contributed to the improvement of wastewater treatment ratio in the urban areas in the City.

(3) Pollutants emission reduction amount

Table 5 shows the baseline and planned figures of emission of major water pollutants: COD, Biochemical Oxygen Demand[11] (BOD) and Suspended Solids[12] (SS) as well as the target reduced amount (target - baseline). Table 6 and Table 7 illustrate the actual emission amount of those pollutants of each WWTP. As those tables show, the targets of the above indicators were achieved at both WWTPs.

Table 5 Pollutant emission amount (baseline and plan) and target reduced amount of the two WWTPs

Unit: ton/year

WWTP	Baseline of emission amount (2001)			Planned emission Amount after proiject completion (2005)			Planned reduced amount		
	COD	BOD	SS	COD	BOD	SS	COD	BOD	SS
Tangjiatuo	30,478	15,374	21,353	5,125	1,708	1,708	25,623	13,666	19,644
Jiguanshi	65,700	32,850	45,625	10,950	3,650	3,650	54,750	29,200	41,975
Total	96,178	48,224	66,978	16,075	5,358	5,358	80,373	42,866	61,619

Source: Questionnaire answer from CDC

Table 6 Pollutant emission amount and reduced emission amount of Tangjiatuo WWTP (actual)

Unit: ton/year

Indicators	Emission amount				Reduced amount from baseline (2010)
	2007	2008	2009	2010	
COD	2,776	2,444	2,504	2,525	27,953
BOD	428	343	360	284	15,090
SS	1,019	1,306	1,271	891	20,462

Source: Questionnaire answer from CDC

Table 7 Pollutant emission amount and reduced emission amount of Jiguanshi WWTP (actual)

Unit: ton/year

Indicators	Emission amount				Reduced amount from baseline (2010)
	2007	2008	2009	2010	
COD	3,982	4,491	4,267	3,872	61,828
BOD	838	855	898	673	32,177
SS	1,467	1,497	1,797	1,420	44,205

Source: Questionnaire answer from CDC

[11] Similar to COD, BOD is also an indicator showing the degree of water contamination and is one of the regulatory parameters of industrial wastewater.

[12] SS are the solids which are suspended in water and cannot be melted.

(4) Improvement of quality of water treated at WWTPs

The density values of COD, BOD and SS after treatment specified in the Grade I-B of the Urban Wastewater Treatment Plant Emission Standards (GB18918-2002), which was revised in 2002, were adopted as the target values for this project. The density of all the parameters of COD, BOD and SS after treatment met the standards. Table 8 shows the baseline, planned and actual density of the three parameters.

Table 8 Density of major pollutants after treatment

Unit: mg/L

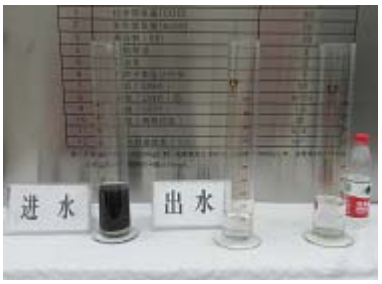
Indicators	2001 Baseline		Plan after Project Completion (Note)		2011 Actual	
	Tangjiatuo	Jiguanshi	Tangjiatuo	Jiguanshi	Tangjiatuo	Jiguanshi
Inlet COD	360	360	360	360	301	323
Outlet COD	360	360	60	60	32	20
Inlet BOD	180	180	180	180	181	152
Outlet BOD	180	180	20	20	4	4
Inlet SS	250	250	250	250	212	438
Outlet SS	250	250	20	20	11	7

Source: Appraisal documents, Questionnaire answer from CDC.
Note: Target values of the density of outlet COD, BOD and SS are in accordance with Grade I-B of GB18918-2002.

It was confirmed during the evaluator's field visit that the wastewater before treatment was black and the treated water was as transparent as mineral water on the contrary.

Overview of sedimentation pond and biological reaction pond

Wastewater Outlet of Juguanshi WWTP



Water before treatment (left), water after treatment (center), mineral water (right)

(5) Improvement of water quality of rivers in Chongqing City

It was confirmed from the interview with the CEPB that the water quality monitoring sections related to this project were Cuntan and Daxiguo sections, which are located between the starting points of wastewater pipes and the ends of the pipes/ the locations of the Tangjiatuo and Jiguanshi WWTPs. The implementation completion and results report of the first stage construction of the two WWTPs (by the loan from the World Bank) use the

data of Cuntan and Daxiguo sections[13] for its evaluation, too.

The time-series data regarding water quality category of Cuntan section of Yangtze River is shown in Table 9. While the water quality of Cuntan section was Class III in 2000, it has been Class II since 2006, thus it can be said that the water quality is on the improving trend.

Table 9 Water quality category at Cuntan section of Yangze River

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Category	III	NA	III	IV	II	III	III	III	II	II	II	II	II

Source: The data of 1998 is drawn from the implementation completion and results report of Chongqing Urban Environment Project (2010). The data after 2000 was provided by CEPB.

According to the above report, while the water quality of Daxiguo section of Jialingjiang River was Class IV in 1998, it was Class II in 2008. According to the Chongqing Municipality State of the Environment Reports, the water quality, not only of Daxiguo section, but also of all the sections under the supervision of the CEPB, has been Class II since 2006[14]. Therefore, it can be assumed that the water quality of Jialing River is also on the improving trend.

The above report indicated the monitoring results of Cuntan and Daxiguo sections between 1998 and 2008 regarding Permanganate Index[15] and BOD5[16], which are particularly important among the 24 parameters regulated by the current National Environmental Quality Standards for Surface Water (GB 3838-2002). The current standards are shown in Table 10. The annual average values of Cuntan and Daxiguo sections are shown in Table 11 and 12. The monitoring results show that the Permanganate Index was reduced by 11% (from 3.10mg/l to 2.77mg/l) and that BOD5 was reduced by 42% (from 1.93mg/l to 1.12mg/l) between 1998 and 2008 in Cuntan section. It also indicates that the Permanganate Index was reduced by 35% (from 4.34mg/l to 2.82mg/l) and that BOD5 was reduced by 49% (from 2.52mg/l to 1.29mg/l) between 1998 and 2008 in Daxiguo section. Comparing with the national standards, the average values of both sections in 2008 are within the limit of Class II.

[13] Source: Implementation completion and results report of Chongqing Urban Environment Project (2010). The original data was from CEPB.

[14] Source: Chongqing Municipality State of the Environment Report 2006, 2007, 2008, 2009 and 2010.

[15] Permanganate Index is same as the Chemical Oxygen Demand by manganese method (CODMn), which has been adopted in Japan. There are two methods for measuring COD: manganese method and chrome method (CODCr). The current national emission standards in China adopt CODCr. However, in 1998, the Chongqing Urban Environment Project set the permanganate index as one of the monitoring items. Thus, the report evaluated the project by using the same index.

[16] BOD5 is the oxygen demand amount when organic matters are cultivated for five days in the room of 20 degrees Celsius.

Table 10 National Environmental Quality Standards for Surface Water (Limit)

Unit: mg/L

Category / Standard Value / Item	Class I	Class II	Class III	Class IV	Class V
Permanganate Index	2	4	6	10	15
BOD5	3	3	4	6	10

Source: The data is drawn from the implementation completion and results report of Chongqing Urban Environment Project (2010). The original data was from the CEPB.

Table 11 Annual average values of Cuntan Section

(unit: mg/l)

Year	Permanganate Index	BOD5
1998	3.10	1.93
1999	2.48	1.32
2000	2.48	1.23
2001	1.91	1.79
2002	2.23	1.56
2003	2.77	1.77
2004	2.36	1.36
2005	2.72	1.29
2006	3.61	1.49
2007	2.57	1.10
2008	2.77	1.12

Table 12 Annual average values of Daxiguo Section

(unit: mg/l)

Year	Permanganate Index	BOD5
1998	4.34	2.52
1999	2.80	1.79
2000	2.46	2.01
2001	2.60	1.53
2002	2.58	1.83
2003	3.23	2.46
2004	2.68	1.49
2005	3.06	1.49
2006	2.70	1.60
2007	2.51	1.79
2008	2.82	1.29

Source: The implementation completion and results report of Chongqing Urban Environment Project (2010). Original data is drawn from the CEPB.

Meanwhile, Yangtze River is 6,300 km long (longest in China) and Jialing River is 1,119km, thus the water quality of those rivers is easily affected by several factors such as the pollution situations of those upstream. In the target area of this project, various actions for water quality improvement had been undertaken: the first stage construction, industrial pollution control, etc. Therefore, it is difficult to verify the relationship between the improving trend of the river water quality and this project. However, based on the facts that this project reduced pollutants emission more than planned and that the wastewater after treatment fulfills the national emission standards Grade I-B, it can be judged that this project had contributed to the improvement of river water quality to certain degree.

3.2.2 Qualitative Effects

3.2.2.1 Water quality improvement of the rivers (Yangtze and Jialing Rivers) in Chongqing City

Beneficiary surveys (100 samples: 65 male and 35 female) were conducted for the

residents along Yangtze and Jialing Rivers[17]. As a result, 80% respondents answered that the river water quality had improved very much, and 20% respondents answered that the quality had slightly improved. There was none who responded “no change” or “aggravated”. Regarding the timing of the water quality improvement, as Figure 3 illustrates, many respondents perceived that the water quality of the rivers had improved between 2006 and 2008. As the project was completed in July 2007, it is considered that not only this project but also the implementation of the first stage construction and the CMPG’s efforts for controlling industrial wastewater contributed to the improvement of river water quality in a synergistic manner.

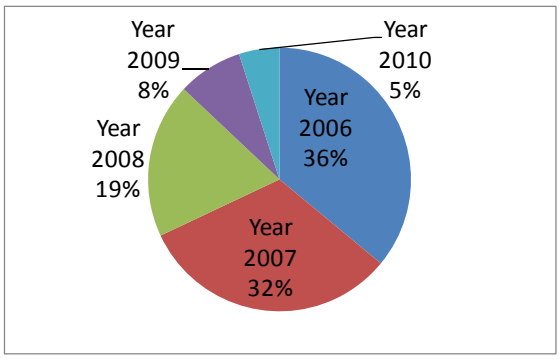


Figure3 Perception of the timing of water quality improvement observed in the beneficiary survey result (N=100)

3.2.2.2 Recycled Effect (Sludge recycling)

Table 13 shows the amount of treated sludge and reused sludge of the two WWTPs.

Table 13 Amount of treated sludge and amount of reused sludge

Unit: ton/day

Indicators	Target for 2010		Actual for 2010		Actual for 2011	
	Tangjiatuo	Jiguanshi	Tangjiatuo	Jiguanshi	Tangjiatuo	Jiguanshi
Amount of treated sludge	48	105	85	269	92	267
Amount of reused sludge	0	0	59 (69%)	90 (33%)	73 (79%)	94 (35%)

Source: Questionnaire answer from CDC

Parts of sludge have been used mainly as cement materials and fertilizer. While the percentage of recycled sludge amount against the processed sludge amount at Jiguanshi WWTP was as low as about 30%, the percentage at Tangjiatuo WWTP is as high as

[17] Gailanxi (Jiangbei) 10 persons, Xiaojiahe (Jiangbei and Yuzhong) 10 persons, former Chang’ An Auto plant (Jiangbei) 10 persons, Hutouya (Shapingba) 10 persons, Heishizi(Jiangbei) 10 persons, fomer Tianyuan Chemical Industry Plant (Jiangbei) 10 persons, Daxiguo (Yuzhong) 10 persons, South Pingyabadong (Nan’ An) 10 persons, Gongyadong (Yuzhong) 10 persons, Jiguanshi 5 persons and Tangjiatuo 5 persons.

between 70 and 80%. According to CDC, this is because the company installed a sludge drying facility at Tangjiatuo WWTP by its own funds in 2009. Out of the total 270 tons/day of processed sludge, Jiguanshi WWTP transports approximately 90 tons/day to a cement factory and reclaims about 180 tons/day. However, as the newly introduced sludge drying facility at Tangjiatuo WWTP was found to be effective, CDC also decided installing the same facility at Jiguanshi WWTP. It is planned to be installed by the end of 2012. It is expected that the recycling ratio will be improved after 2013.

3.3 Impact

3.3.1 Intended impacts

3.3.1.1 Improvement of living environment

The planned and actual target areas and service population under this project are summarized in Table 14. While the target area increased than planned, the target population is same as the planned. The target districts increased from six to seven. The reason for this increase was that Liangjiang New District, a new administrative district, was added[18].

Table 14 Target area and service population (Plan and actual)

	Area (unit: km^2)			Target population (unit: ten thousand)			Target Districts
	Target for 2005	Target for 2010	Actual 2011	Target for 2005	Target for 2010	Actual 2011	
Tangjiatuo	46	68	100	80	88	82	Yubei, Liangjiang New, Jiangbei (Northern and eastern area of Chongqing City Proper)
Jiguanshi	98	108	315	130	154	144	Nan'an, Yuzhong, Jiulongpo, Shapingba (Southern area of Chongqing City Proper)
Total	144	176	415	210	242	226	

Source: Plan from JICA appraisal document. Actual from Questionnaire answer from CDC.

According to the beneficiary survey, 97% respondents answered that the domestic sanitary environment had improved by the installation of toilets and connection of wastewater pipes. 100% respondents answered the living environment in the city had improved. The installation of toilets and connection of wastewater pipes were not included in this project; however, without the wastewater treatment facility under this project, those

[18] Source: Questionnaire answer from CDC.

installations could not be carried out. Thus, the improvement of the domestic sanitary environment can be considered as indirect effect of this project.

The following points were raised by the respondents regarding the improvement of the river water quality.

- Water quality at Chaotianmen (cross-section between Yangtze and Jialing Rivers) has improved. Sanitary environment along Jiubin Road (along Yangtze River in Yuzhong District) has improved. In the past, flow of black liquid was observed in Yangtze River along Nanbin Road (Nan'an District), but such black water is no longer observed. The water in the Three Gorges Dam is cleaner than before.
- Odor from ditches disappeared. Odor along Beibing Road in Zhangbei District (along Jialing River) disappeared. No odor of rivers is sensed when taking ferries. (Because no odor is sensed,) people can open the windows of the room.
- The number of flies and mosquitoes has decreased.
- People can fish at Chaotianmen. The fish from the rivers can be eaten now.
- People can swim in the rivers now.
- The river water near Jiguanshi WWTP has become clean, and boat tours are available now.

It cannot generalize from the above beneficiary result due to the limited samples, but as shown above, it implies that the improvement of water quality of Yangtze and Jialing Rivers has been appreciated by the residents and that the recreation activities such as fishing, swimming and boat tours became available. It is considered that the CMPG's continuous efforts for improving river water quality including this project have contributed to the improvement of sanitary situations and the living environment.

3.3.2 Other impacts

3.3.2.1 Impacts on the natural environment

No particular negative impact on the natural environment has been observed from the data provided by CDC and the EPB, field observation, beneficiary survey, etc.

Regarding the environmental monitoring system, both WWTPs regularly conduct water quality inspection of inlet and outlet wastewater. While there are eight parameters (BOD, COD, TN, NH3-N, TP, pH, SS and coliform) for daily inspection, there are four parameters (oil extracted from animals and plants, petroleum oil, surface-active agent and

chromaticity) for monthly inspection[19]. Water quality after treatment fulfills the national emission standard Grade I-B. Both WWTPs are connected with the major pollutant source monitoring system established by the Environment Model City Project[20], thus major parameters are ready for confirmation at the monitoring center every hour.

[Sludge processing]

Heavy metal content test fulfills the national standards. Some parts of sludge have been re-used as cement materials and fertilizers, others have been filled at the final disposal site properly.

[Odor and noise]

Both WWTPs are located away from the residential areas. According to the beneficiary survey, no negative impact on odor and noise has been observed.

3.3.2.2 Land acquisition and Resettlement

According to the report[21] of the first stage construction by the loan from the World Bank, resettlement and land acquisition went smoothly during the first stage construction, and the compensation for the resettled residents was paid properly. During the second stage construction under this project, there was no resettlement and land acquisition.

3.3.2.3 Unintended Positive/Negative Impact

In Chongqing City, the view of Yangtze and Jialing Rivers itself is a sightseeing resource, thus it is assumed that the water quality improvement of those rivers has also brought economic effects. The CMPG constructed a few kilometers long walking trails and some parks along the rivers. It was also reported that number of boat restaurants and river-view restaurants and observation decks were increasing around the Central Peninsula, which is the intersection of Yangtze and Jialing Rivers, year by year [22]. Although it was not possible to obtain the data which illustrates the water quality improvement of the rivers and the development of sightseeing and food industry, CMPG's continuous efforts for improving water quality including this project and construction of walking trails are considered to

[19] Source: Questionnaire answer from CDC.

[20] The Environment Model City Projects were the loan projects from the Government of Japan as a part of the Environment Model City Framework. The projects were conducted in the cities of Chongqing, Dalian and Guiyang in order to improve environment by implementing air pollution control intensively and building environment monitoring system and then to replicate the successful cases in other cities in the end. In Chongqing, the following sub-projects were carried out between 2000 and 2009: the extension of natural gas supply system, establishment of the pollutants monitoring system and the installation of flue-gas desulfurization (FGD) equipment.

[21] Implementation Completion and Result Report of Chongqing Urban Environment Project (2010).

[22] Source: Interview with CDC.

have supported the development of sightseeing and food industry in Chongqing City.

This project has largely achieved its objectives, therefore its effectiveness and impact is high.

3.4 Efficiency (Rating:②)

3.4.1 Project Outputs

The scope of this project for the two plants is summarized in Table 15. Outputs were completed as planned, except the facility to accelerate the speed of sludge drying process.

Table 15 Output (Planned and actual)

Items	Plan	Actual
Tangjiatuo with the capacity of 300,000 m^3/day	1) Civil work, procurement of equipment Sludge treatment facility, primary sedimentation ponds, biological reaction ponds, secondary sedimentation ponds, etc. 2) Consulting services a) construction management b) Technical training for wastewater treatment i Transfer of sludge recycling technology ii Transfer of technology required for O&M including water monitoring	As planned
Jiguanshi with the capacity of 600,000 m^3/day	Same as above	Almost as planned except the addition of the facility to accelerate the speed of sludge drying process (Voltage stabilizer, boilers and antiseptic injection facility).

Source: JICA appraisal documents, Questionnaire answer from CDC.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The total project cost estimated at appraisal was 13,747 million yen (of which the Japanese ODA loan amount was 9,017 million yen and the rest was to be locally funded). The actual total project cost was 12,123 million yen (of which the Japanese ODA loan amount was 9,017 million yen and the rest was locally funded), which was 88% of the planned amount. The total cost decreased from the plan due to efficient order placement by competitive bidding.

3.4.2.2 Project Period

The project period exceeded the planned. The planned project period at appraisal was from March 2002 (Loan Agreement signing) to December 2005 (project completion), for a total of 45 months. The actual period was from March 2002 (Loan Agreement signing) to

July 2007 (project completion), for a total of 64 months (142% of the planned period). The reasons for the delay are described below[23]:

1) Delay of procurement procedures by six months due to the prevalence of Severe Acute Respiratory Syndrome (SARS);
2) Sharp rise in material price between 2002 and 2004 required deliberate consideration and counter-measures for design, preparation for bidding process and bidding evaluation, which took approximately one year;
3) During the project implementation period, it was claimed by the landfill plant, which receives sludge from Jiguanshi WWTP, that the WWTP needed to accelerate the speed of sludge drying process in order to prevent secondary contamination. Thus, it required changing the design of sludge processing system and changing the facilities;
4) Due to the special structure of egg-shaped sludge digestion tanks, there was a slight delay in design and civil work; and
5) During the project implementation period, geological conditions required the adjustment of working drawing and contents.

However, the delay during the construction is minimal. One of the reasons is that the Japanese consultant and the local management company conducted construction management properly. According to CDC, as a result of the appropriate construction management, this project resulted in winning the National Good Project Silver Prize in 2007 (Tangjiatuo) and in 2008 (Jiguanshi).

3.4.3 Results of Calculations of Internal Rate of Return (reference only)

Using the same assumptions at appraisal[24], the financial internal rate of return (FIRR) was recalculated as shown in the table below. The reason for the higher FIRR of Tangjiatuo WWTP at the ex-post evaluation than planned could be that the wastewater treatment charge was raised from 0.8 RMB/m^3 to 1.24 RMB/m^3. FIRR of Jiguanshi WWTP was not recalculated due to lack of some data. However, the FIRR of CDC is 10.14%, thus it can be said that there is no problem. The economic internal rate of return (EIRR) was not calculated at appraisal, therefore was not recalculated at the ex-post evaluation.

[23] Source: PCR, JICA documents, Questionnaire answer from CDC and interviews.
[24] The assumption used at the appraisal is that the total project cost and increased operation/maintenance costs during the operation stage, are “costs” and that the income from the wastewater treatment charges is “benefits”, Project life: 20 years.

Table 16 Financial internal rate of return (FIRR)

	At the time of Appraisal	At the time of ex-post evaluation
Tangjiatuo WWTP	8.2%	9.12%
Jiguanshi WWTP	5.5%	NA
Chongqing Drainage Company Overall	NA	10.14%

Source: JICA appraisal document and questionnaire answer from CDC

Although the project cost was within the plan, the project period was exceeded the plan, therefore efficiency of the project is fair.

Photo provided by CDC

Tangjiatuo WWTP (Left: Yangtze River, left egg-shaped facility: sludge digestion tank, right: sedimentation ponds and biological reaction ponds, etc)

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance (O&M)

The executing agency was the CMPG, but the implementing agency was CDC, which is a national company established in 1999. In 2001, Chongqing Water Group Co., Ltd. (CWG) consisting of 22 subsidiary companies was established, and CDC became one of those subsidiaries. CWG is one of the eight biggest investment groups in Chongqing City with a market value of 33.5 billion RMB. CWG is responsible for protecting water environment of the middle and lower reaches of the Yangtze River and has been the biggest enterprise group in China that works on water protection of the reservoir of the Three Gorges. CWG operates plants with a daily water supply capacity of 2,030,000 m^3 and a daily wastewater treatment capacity of 2,080,000 m^3 as a group.

Operation and maintenance of Jiguanshi WWTP is managed by CDC. Meanwhile, CWG and Sino French Water Investment Company[25] established Chongqing Sino French Tangjiatuo Wastewater Treatment Co. Ltd. in 2007, and the company is responsible for

[25] Sino French Water Investment Company is a company which merged with French private company.

operation and maintenance of Tangjiatuo WWTP by obtaining management right from the CMPG. Number of staff of the two WWTPs is summarized in Table 17.

Table 17 Number of staff by position

Unit: persons

Position	Chongqing Drainage Company	Jiguanshi WWTP	Tangjiatuo WWTP
Manager	5	0	12
Senior Engineer	14	2	3
Engineer	27	4	6
Technical staff	50	4	30
Technician	5	2	3
Skilled worker	191	88	46
Total	292	100	95

Source: JICA appraisal document and responses to the questionnaire

Note 1: Because Tangjiatuo WWTP is managed by Chongqing Sino French Tangjiatuo Wastewater Treatment Co. Ltd., the managers are different from the managers of CDC. 3 senior engineers and 2 engineers also functions as managers.

Note 2: Tangjiatuo WWTP include foreign staff.

In light of the above, no major problem has been observed in the operation and maintenance system. It can also be said that the number of staff required for operation and maintenance has been ensured.

3.5.2 Technical Aspects of Operation and Maintenance

The number of operation and maintenance staff by position is shown above. It was confirmed through the interview with CDC that the contents of the training on wastewater treatment technology which was conducted under this project was appropriate and that operation and maintenance has been carried out without major problems since operation partly because of the training. The regular training by the implementing agencies includes safety production, quality control, wastewater treatment regulations, company management system and finance. Training is conducted not only at the WWTPs, but also at the training center of CWG and that of Chongqing Sino French Tangjiatuo Wastewater Treatment Company. CWG was awarded as one of the top ten companies at the national wastewater treatment operation inspection in 2008. Jiguanshi WWTP was also awarded as one of the national top ten wastewater treatment plants[26].

As mentioned above, training contents and training opportunities are sufficient; operation and maintenance has been managed without major problems since operation; CWG and Jiguanshi WWTP have received nation-wide high reputation for their performances; Tangjatuo WWTP has been making continuous efforts to improve

[26] Source: Introduction of Jiguanshi WWTP.

wastewater treatment technology by its cooperation with a French company, which invests in Sino French Water Investment Group. Thus, it can be said that both WWTPs have necessary technical capacities in operation and maintenance.

3.5.3 Financial Aspects of Operation and Maintenance

Both at the time of appraisal and at the ex-post evaluation, wastewater treatment charges have been collected together with the water charges by the CMPG. Wastewater treatment tariff in Chongqing City are shown in Table 18. Wastewater treatment tariff has been revised together with water tariff, and the range of its increase has been almost as planned. In addition, according to the beneficiary survey, 92% respondents answered that the tariff was reasonable. Thus, it can be said that the tariff is reasonable.

Table 18 Wastewater charges in Chongqing City

unit: yuan /m^3

Category	Plan for 2005 (Project Completion)	Plan for 2010	2006 Actual	2007-2009 Actual	2010- Up to present Actual
Household	0.8	1.5	0.6	0.7	1.0
Commerce			0.9	1.0	1.3
Industry			0.9	1.0	1.3

Data source: Questionnaire Answer from CDC.

At the time of appraisal, it was planned that the CMPG allocated necessary expenses for operation and maintenance to each WWTP and that the CMPG provided subsidies in case of lack of funding. After the project completion in 2007, it changed that charges were paid by unit in accordance with the amount of treated wastewater. Under the contract between the CMPG and CDC, the unit price for wastewater treatment is 3.25 yuan m^3/day. It made possible for CDC to allocate the revenue not only for operation and maintenance cost but also for future investment in facilities.

Table 19 shows the financial situation of CDC. After the project completion in 2007, gross revenue and profit increased due to the above reason and the increase of treatment amount.

In addition, taking the opportunity of the above change of pricing method, CDC has been making efforts for business improvement such as streamlining of operation work and cost cut, which resulted in an increase of profit. Thus, no major problem has been observed in terms of financial sustainability. Financial statement of Chongqing Sino French Tangjiatuo Wastewater Treatment Company could not be obtained.

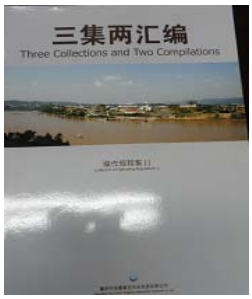
Table 19 Financial situation of Chongqing Drainage Company

Item	2006	2007	2008	2009	2010
Gross revenue	202.63	639.49	761.39	785.37	824.13
Selling, general and administrative expenses	202.31	261.63	406.59	314.21	405.99
(Operation and maintenane cost)	103.5	138.9	273.81	185.86	269.76
Operating profit	0.32	377.86	354.8	471.16	418.14
Total assets	3211.95	3394.84	3655.85	3600.47	3595.4
Current assets	338.11	875.05	1014.95	991.65	1069.27
Non-current assets	2873.84	2519.79	2640.9	2608.82	2526.13
Current liabilities	208.49	117.6	94.87	57.48	50.12
Shareholder's equity	1285.09	1268.63	1271.63	1271.63	1591.77
Liabilities	1926.86	2126.21	2384.22	2328.84	2003.63

Data source: Questionnaire Answer from CDC.

3.5.4 Current Status of Operation and Maintenance

According to the degree of difficulty in operation and maintenance, equipment is categorized into three types: important equipment, major equipment and general equipment. Operation and maintenance plans have been formulated respectively for each category. It was confirmed during the evaluator's field visit that the facilities of both WWTPs were organized and maintained well. Manuals have also been developed well. Major handbooks and manuals confirmed during the field visit are listed below.



Tangjiatuo WWTP operation manual

Jiguanshi WWTP operation regulation, handbooks, etc.

Tangjiatuo WWTP: regulations/system manual, operation manual, emergency response manual, operation flow chart and record formats.
Jiguanshi WWTP: Staff handbook, safety production handbook, facility safety operation regulations and operation safety regulations.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Government of China and the CMPG gave priorities to water pollution control of Yangtze River and its tributary, Jialing River, and have undertaken various actions. This project was implemented as a part of such efforts. In Chongqing City, due to rapid urbanization and industrialization, domestic and industrial wastewater increased, thus water contamination was worsened. In addition, as Three Gorges Reservoir is located in the downstream of Yangtze River, it was urgent and highly necessary to improve the water quality of the rivers by constructing wastewater treatment facilities. The following expected effects have been observed almost as planned: the increase of wastewater treatment capacity, reduction in pollutants emission, improvement of quality of treated water, improvement of water quality of the rivers in the city. These effects have been contributing to the enhancement of the living standards of the residents along the rivers. Therefore, the effectiveness and impact is high. Although the project cost was within the plan, the project period exceeded the plan, therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

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

4.2 Recommendations

4.2.1 Recommendation to the Executing Agency

None.

4.2.2 Recommendation to JICA

None.

4.3 Lessons Learned

None.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Output 1) Civil work, procurement of equipment 2) Consulting services	Tangjiatuo with the capacity of 300,000 m^3/day and Jiguanshi with the capacity of 600,000 m^3/day Sludge treatment facility, primary sedimentation ponds, biological reaction ponds, secondary sedimentation ponds, etc. a) construction management b) Technical training for wastewater treatment i Transfer of sludge recycling technology ii Transfer of technology required for O&M including water monitoring	Tangjiatuo: As planned. Jiguanshi: Almost as planned except the addition of the facility to accelerate the speed of sludge drying process (Voltage stabilizer, boilers and antiseptic injection facility). As planned.
2. Project Period	March 2002-December 2005 (45 months)	March 2002-July 2007 (64 months)
3. Project Cost Foreign currency Local currency Total Japanese ODA loan Exchange rate	 9,017million yen 4,730million yen (315million yen) 13,747million yen 9,017million yen 1yuan=15Japanese Yen (As of September 2001)	 9,017 million yen 3,106million yen (218 million yen) 12,123 million yen 9,017 million yen 1yuan=14.28yen (Average between March 2002 and July 2009)