People's Republic of China

FY2018 Ex-Post Evaluation of Japanese ODA Loan Project

"Guangxi Zhuang Autonomous Region Yulin City Water Environment Improvement Project"

External Evaluator: Kenji Momota, IC Net Limited

0. Summary

This project was conducted for the purpose of reducing water pollutant emissions and supplying water safely and stably to improve the living environment of the local residents by establishing clean water infrastructure and sewage treatment facilities in Yulin City, Guangxi Zhuang Autonomous Region. The relevance of this project is high because of its conformity with the Japanese government's policies and needs as well as Chinese policies and needs. While the scope of the project has been revised and the period has been extended, the infrastructure has been established mostly as planned, and thus the efficiency of this project can be evaluated as fair. Since the implementation of this project, the water supply and sewage infrastructure has been operating satisfactorily, with highly effective reduction of water pollutants through the construction and operation of sewage treatment facilities. The water supply system has also been operating steadily, responding to the increasing demand and providing a stable water supply to the local residents. The expansion and improvement of the water and sewage infrastructure are still ongoing. Additionally, the responsible organizations have been structured with stable foundations with regard to technology and finances, which indicate good sustainability. In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project Location

Nanliujiang River flowing through Yulin City

1.1 Background

While China has achieved rapid economic growth, the industrialization and population increase have been causing environmental pollution since the 1980s. The government of China has been working hard to protect the water environment, but the sewage treatment rate in urban

areas has been less than 50% while the household water usage has increased. With the increasing pollution of water resources caused by untreated sewage, it has become an imperative to treat household wastewater. Although the water supply coverage rate in China as of 2004 was 89%, the water resource amount per person was 2,040 m^3/person, which is only a quarter of the world average. Delay in water price reforms and water leakage due to aging infrastructure are some of the issues that surfaced. It was a great concern to develop new safe water sources, and improve the efficiency of water source usage, as well as to improve the existing water supply systems to promote the availability of water-saving techniques.

In Yulin City, Guangxi Zhuang Autonomous Region, located in the southwestern part of China, while the sewage discharge increased along with economic growth, the development of sewage treatment facilities had not caught up and a sewage plant for treating household wastewater had yet to be established. Untreated wastewater was directly discharged into the Nanliujiang River, Yulin City's main water source, and was causing pollution in the river. Excessive drawing of water from underground water sources and water contamination also occurred, making the development of stable and safe water sources in place of the Nanliujiang River and underground water an urgent matter.

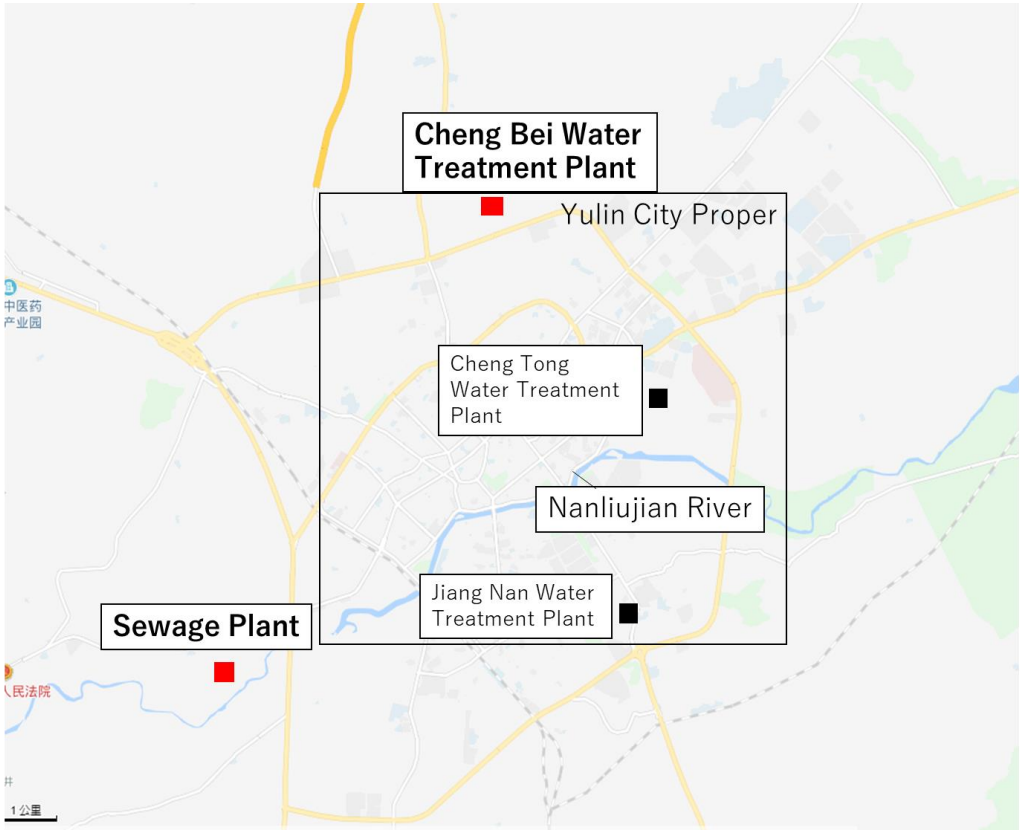
1.2 Project Outline

The objective of this project is to reduce the water pollutant emissions flowing into the Nanliujiang River, which is located in Yulin City, Guangxi Zhuang Autonomous Region, and suffering from significant water pollution, as well as to provide a stable and safe water supply for Yulin City by developing a water supply and sewage infrastructure in this area, thereby contributing to the improvement of the living environment of the Yulin City residents.

Loan Approved Amount/ Disbursed Amount	6,282 million yen / 5,736 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	June 2006 / June 2006
Terms and Conditions	[Sewage Treatment Project] General untied, 0.75% interest rate, 40-year repayment period, and 10-year grace period [Water Diversion Project] General untied, 1.5% interest rate, 30-year repayment period, and 10-year grace period [Training] General untied, 0.75% interest rate, 40-year repayment period, and 10-year grace period
Borrower /	The Government of the People's Republic of China /

Executing Agency	Yulin People's Government (YPG)
Final Disbursement	October 2015
Main Contractors (Over 1 billion yen)	1. Hubei Rich States Industry Investment Co., Ltd. (People's Republic of China) / China Ove Environmental Engineering Co., Ltd. (People's Republic of China): Provision of machinery and other supplies 2. China Ove Environmental Engineering Co., Ltd. (People's Republic of China): Provision of machinery and other supplies
Main Consultant	N/A
Related Studies (Feasibility Studies, etc.)	FS: Prepared by the Guangxi Environmental Protection Research Institute, October 2005
Related Projects	N/A

The map below shows the relationship among the central part of Yulin City, the project site, and the Nanliujiang River.



Source: Prepared by External Evaluator using Baidu Maps (URL: http://map.baidu.com/)

2. Outline of the Evaluation Study

2.1 External Evaluator

Kenji Momota, IC Net Limited

2.2 Duration of Evaluation Study

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

Duration of the Study: September 2018 – October 2019

Duration of the Field Study: January 18 – 30, 2019 and May 12 – 30, 2019

2.3 Constraints during the Evaluation Study

Of the evaluation items for efficiency, the project cost requires the calculation of the total project cost with the addition of the part borne by the partner government to the original Japanese ODA Loan part. However, in this study, as it was impossible to calculate the accurate amount of the part borne by the partner government, the project cost was evaluated only by a comparison using the Japanese ODA Loan parts.

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

3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of China

(1) Development policy at the time of the appraisal

The government of China had a goal of reducing the total emission of major pollutants by 10% compared to that from 2000 and reaching a 45% sewage treatment rate in urban areas[3] in *the 10th Five-year Environmental Protection Plan (2000–2005)* (hereinafter "*10th Five-year Plan*"). In the subsequent *11th Five-year Environmental Protection Plan (2006–2010)* (hereinafter "*11th Five-year Plan*"), the government of China set water quality improvement goals for core target areas for environmental protection for the improvement of water environments. In addition, the government of China established a drinking water source protection zone, set the goal of a 70% urban sewage treatment rate by 2010, and stepped up the construction of urban sewage treatment facilities and the collection of sewage treatment fees in order to strengthen the regulation on pollutant emissions to major rivers, lakes, and reservoirs. On the other hand, the development of a water supply system focused on the establishment of urban water supply infrastructure and the procurement of water sources for water-short areas in *the 10th Five-year Plan* and *the 11th Five-year Plan*. In particular, the Plans aimed to conserve water sources by increasing water supply capacity, securing safe drinking water, and reducing

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

[2] ③: High, ②: Fair, ①: Low

[3] In cities with a population of more than 500,000 people had a goal of attaining a 60% urban sewage treatment rate.

water leakage rate through building new water facilities and upgrading aging facilities in the urban areas.

In response to this, the Yulin People's Government set up the Nanliujiang River as one of the core areas for environmental protection in *Yulin City's 10th Five-year Environmental Protection Plan (2001–2005)* and focused on solutions for environmental pollution and ecological destruction. The Yulin People's Government set forth in *the Yulin City General Urban Plan (2004–2020)* to construct a sewage plant with a processing capacity of 450,000 m^3 per day on the western side of the Yulin City Proper and set up a goal to solve the water source shortage problem by diverting water from the Yujiang River that runs through Guigang, a city adjacent to Yulin City.

(2) Development policy at the time of the ex-post evaluation

1) National-level policy

There is no significant change in the development policy at the time of the ex-post evaluation. Regarding water pollution, the central government planned to reduce major water pollutants and conserve drinkable water sources by developing a separated sewerage network and constructing sewage treatment facilities as set forth in the *12th Five-year Environmental Protection Plan (2011–2015)* (hereinafter "*12th Five-year Plan*"). Specifically, the central government was aiming to develop basic sewage treatment capacity in all counties and major townships, and increase the load rate of sewage treatment facilities to 80% or higher and the urban sewage treatment rate to 85%. In the subsequent *13th Five-year Environment Protection Plan (2016–2020)* (hereinafter "*13th Five-year Plan*"), the central government set the goal of improving the rates of the National Surface Water Quality Standard Classes I through III[4] to 70% or higher. This Plan also sets the goals of establishing sewage collection and treatment capacities in all townships with county municipal governments and other core townships by 2020 and significantly raise the sewage treatment rate through constructing urban sewage plants and sewerage networks as well as promoting a separate treatment network for rainwater and wastewater and preferentially promoting the connection to wastewater networks for rural areas. Regarding the water supply policy, *the 12th Five-year Plan* set forth a goal for improving the quality of the water environment and listed stricter protection on drinkable water sources and regulations on pollutant discharge ports as specific efforts. In the subsequent *13th Five-year Plan*, the government set a goal to improve the quality rates (Classes I through III) of

[4] The water quality of rivers is classified into Classes I through V by the Surface Water Environment Mass Standard (GB3838-2002). Class I: Primarily water source water. National nature reserve, Class II: Primarily household drinking water. First-grade reserve, rare fish reserve, fish/shrimp spawning ground, Class III: Primarily household drinking water. Second-grade reserve, general fish reserve, swimming area, Class IV: Primarily general industrial water. General industrial water zone, entertainment water zone where water does not come into direct contact with human bodies, Class V: Primarily agricultural water. Agricultural water zone, applied to be secured for general landscape.

centralized drinking water sources at provincial- or prefectural-level cities to 93% or higher by 2020 through preferential protection of good water areas.

2) Municipal-level policy

In Yulin City's *13th Five-year Environmental Protection Plan (2016–2020)*, the municipal government set a goal to improve the rates of the National Surface Water Quality Standard Classes I through III to 96.2% or higher by 2020 through reducing the total amount of river inflow pollutants by strengthening the control of the river basin environment. Additionally, for the protection of drinkable water sources, the municipal government aims to introduce an environmental safety evaluation and establish a sustainable water source management mechanism. The government has also set a goal to reach a water quality standard attainment rate of 94.9% or higher for centralized drinking water sources for municipalities by 2020 through strengthened supervision of pollutant sources. This is also reflected in *the Yulin City General Urban Plan (2004–2020)*, which sets forth a goal of attaining a 85% sewage treatment rate, along with the development of sewage treatment facilities and the promotion of separating rainwater and wastewater sewerage in the city proper. The water supply policy specifies the Suyan Dam, Luotian Dam, and Yujiang River as the primary water sources to divert water from, and the Nanliujiang River and Qingwanjiang River as secondary water sources. It also mentions the development of the Chengbai Water Treatment Plant, Jiangnan Water Treatment Plant, and Chengtong Water Treatment Plant among the specific measures.

This project constructs a sewage treatment system in Yulin City to improve the water quality of the Nanliujiang River, where wastewater and processed water are currently discharged. The project also aims to stably supply safe water by diverting water after developing safe water sources and constructing a water supply system. Therefore, it is highly consistent with the development policy of the government of China, which endorses the reduction of pollutants and the improvement of water environments as core missions.

3.1.2 Consistency with the Development Needs of China

According to the documents at the time of the appraisal, a sewage treatment system for treating household wastewater had yet to be established in Yulin City, and the sewage treatment rate as of 2004 was approximately 11%. Consequently, 150,000 m^3 of household wastewater was discharged into the Nanliujiang River on a daily basis, causing the water quality of the river to deteriorate below Class V from severe water pollution. In addition, a rapid increase in the demand for clean water had led to an excessive drawing of underground water, which triggered ground subsidence and water contamination. Thus, the development of stable, safe water sources was urgently needed. While the daily maximum water supply from the Suyen Dam and other major water sources at the time was approximately 90,000 m^3 per day, the maximum

water usage in one day by the Yulin City Proper in 2003 was 192,300 m^3 per day, which is a demand more than double the supply. Furthermore, as it was forecast that the maximum water supply was to reach approximately 370,000 m^3 per day by 2015, which made the development of new water sources to replace the Nanliujiang River and underground water a pressing issue.

The needs remain mostly unchanged at the time of the ex-post evaluation. Yulin City has been undergoing economic growth since 2006, when the appraisal was conducted. As of 2018, the population has grown to approximately 5.81 million, with 740,000 people living in the city proper (increased by 4% and 6%, respectively, compared to the population in 2006). The sewage plant constructed in this project is still the only public sewage plant as of today. As of 2017, the household wastewater (12,000 m^3/day) from rural areas outside of the target area of this project[5] was discharged untreated into the Nanliujiang River. Improving the water quality of the Nanliujiang River is still a persisting issue, including the fact that the water quality of the river was observed to have deteriorated to Class V of the National Surface Water Quality Standard as of 2017. The water supply development also needs to take into account the significant increase in the regional population and the resulting expansion in the water supply target areas, alongside the general population increase and economic growth. The Yujiang river water source that has been developed by this project replaces the Nanliujiang River, whose water quality deteriorated. Therefore, the project is highly necessary to use the river for water supply to the city proper. Furthermore, along with the expansion of the city proper to the former townships and villages, the target area of this project was expanded to replace underground water with the surface water of the Yujiang River as water sources for the former townships and villages.

As described above, Yulin City continued and continues to grow economically after the appraisal. The need for water and sewerage infrastructure continues to intensify with the increasing population associated with urban development, and thus it remains highly consistent with this project.

3.1.3 Consistency with Japan's ODA Policy

In *the Medium-Term Strategy for Overseas Economic Cooperation Operations (2004 to the first half of 2007),* among the core areas including the aid for combating poverty, establishment of infrastructure for sustainable growth, and support for global issues and peacebuilding, the Japan International Cooperation Agency (hereinafter "JICA") focuses on rural development by establishing water and sewerage infrastructure in poverty-stricken areas, promotion of sustainable growth by establishing needed socioeconomic infrastructure such as water and sewerage systems and energy facilities, and prevention of water supply pollution, and hence aims for compatibility between development and environmental protection.

[5] At the time of the ex-post evaluation, they are included in the treatment target area of the Yulin City sewage plant.

Additionally, in its *Country Assistance Strategy*, JICA specifies environmental problems caused by rapid economic growth as issues and includes environmental conservation centering on inland areas as a core effort.

This project establishes the water and sewerage systems, which is the social infrastructure underlying the urban development and industrial progress in Yulin City, located inland, and aims to improve the water quality of rivers and the living environment of residents through such undertakings. Therefore, the project is highly consistent with Japan's ODA policy.

3.1.4 Appropriateness of the Project Plan and Approach

(1) Differences between the plan and achievements of the Yujiang Water Diversion Project

The water supply system development project in this project aimed to complement the existing water sources, which were insufficient to meet the demand at the time of the appraisal. The project planned to build a 75-km channel from Yulin City to the Yujiang River to supply 250,000 m^3 of water per day to an area including the region along the channel.

The actual amount of water drawn from the Yujiang River at the time of the ex-post evaluation (2019) was approximately 90,000 m^3 per day, which is slightly less than 40% of what was initially planned. There are two reasons for this difference: 1. the existing water sources are still used because of their lower cost compared to the cost of drawing water from the remote Yujiang River, the cost of which nearly doubled since the initial estimates; and 2. The amount of water available from the existing water sources has been greater than estimated, and has been able to support the current demand.[6] The current state of supply and the background are detailed below.

1) The water treatment plants in Shanxin Township and Dapingshan Township, both of which supply was planned for in this water diversion project, and the Chengtong Water Treatment Plant, whose water source is the Nanliujiang River, continue to draw water from dams that cost less to draw from.
2) The major factors behind the increase in the cost of diverting water from the Yujiang River include the increased maintenance costs (including personnel costs and electricity costs) from the delay in the completion of the project and the increase in the unit cost due to the sluggish growth of the water drawing amount. The estimation of the water diverting cost at the time of planning has some unclear factors regarding appropriateness, such as whether the depreciation of equipment investment was considered in the calculation.

[6] At the time of planning, the cost of diverting water from the Yujiang River was estimated to be an expenditure of an annual 42.57 million yuan when supplying water at 200,000 m^3 per day. The actual cost in 2017 was 82.6 million yuan, approximately double the planned expenditure, including personnel costs, increased interest rate, and depreciation. On the other hand, the cost of drawing water from the Suyen Dam in 2017 was an annual 41.73 million yuan including electricity costs, operation and maintenance costs, personnel costs, and interest rate, which is about half of the above.

3) Additionally, there is a possibility of an error in the estimation of the maximum limit of the amount of water that can be drawn from the Suyen Dam.[7] Moreover, given that a water source that was not being considered as a water source at the time of planning is currently being used, it is unclear how far the current state and the availability of the existing water sources were studied at the time of planning.

The demand for clean water is growing amid the continued development of Yulin City, and the reliance on existing water sources has already come to its limit. The amount of water to be diverted from the Yujiang River is expected to increase in the future. The cost of diverting water is also expected to decrease as the amount of water diverted increases, and therefore, the need for the water diversion project is high in a medium-to-long term perspective. Nevertheless, the operating status up to this date, since the completion of the project, significantly underruns the initial plan. This situation is considered to stem from insufficient review at the time of planning. With regard to appropriateness of the project plan, there is room for improvement, such as a more detailed review of alternative water sources.

From the above, while a few issues are found in the appropriateness of the project plan and approach, it is fair to say that, the project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The plan and actual performance of this project are as shown in the table below. The initially planned outputs were mostly developed as planned. However, because some of the facilities that were initially planned to be developed using the Japanese ODA Loan fund were actually implemented by an independent fund, the outputs as a Japanese ODA Loan project have been significantly altered.

[7] The actual amount of water drawn from the Suyen Dam for the Yulin City Proper with Chengbai Water Treatment Plant and Chengtong Water Treatment Plant combined is 146,300 m^3 per day in 2018, which surpasses the estimated maximum amount of water that can be drawn from the dam.

Table 1: List of Project Outputs

	Plan	Actual
Sewage treatment system	Sewerage network: 156 km	Development by Japanese ODA Loan is significantly reduced (23.76 km) 130 km was developed by a national road development project fund. The overall development is 153.76 km, mostly in line with the plan.
	Sewage pumping station (2 new establishments) Binjiang Road Pumping Station Nanmentang Embankment Pumping Station	Changed to 1 establishment (1 minus) Binjiang Road Pumping Station was constructed using national funds and thus was removed from the scope of the Japanese ODA Loan project.
	Sewage treatment plant (1 new establishment): Yulin City Sewage Plant 100,000 m^3/day	As planned
Water supply system	Water supply channel: 75 km	Mostly as planned (74.02 km)
	Water supply pumping stations: 4 Watang Pump Station 250,000 m^3/day Zhanjiang Pump Station 220,000 m^3/day Mingshui Pump Station 210,000 m^3/day Fumian Pump Station 30,000 m^3/day	3 establishments (1 minus) Fumian Pumping Station was constructed using national funds and thus was removed from the scope of the Japanese ODA Loan project.
	Water treatment plants (2 new establishments) Shanxin Water Treatment Plant 10,000 m^3/day Dapingshan Water Treatment Plant 10,000 m^3/day	Canceled Constructed using national funds and thus were removed from the scope of the Japanese ODA Loan project.
	Water treatment plant (1 expansion): Chengbai Water Treatment Plant Expanded from 100,000 m^3/day to 270,000 m^3/day	As planned
	Water distribution pipe network: 12 km	23.62 km (197% compared to plan)
Training	Training in Japan regarding water and sewage operations, targeting the personnel of the executing agency	Canceled Substitute training has been given domestically

Source: The plan data is based on documents provided by JICA while the actual performance data is based on responses given in a questionnaire issued to the project executing agency.

The major changes to the project outputs are described below.

(1) Sewage treatment facilities

A sewage pump station (Binjiang Road Pumping Station) was removed from the scope of the Japanese ODA Loan project and constructed using national funds in 2017. The negotiation with farmers who own the land planned for the construction of the Binjiang Road Pumping Station

did not go smoothly; thus, acquiring a different land for the construction was considered. This led to the review and revision of the basic design, which required time to obtain permission from the Land Management Section. To prevent this delay from causing the development of other relevant coordinating facilities of the Japanese ODA Loan project to stagnate, the development of the pumping station was removed from the scope of the Japanese ODA Loan project and was constructed using national funds.

Yulin City Sewage Plant (bioreactor)

Nanmentang Embankment Sewage Pump Station (coarse screen)

(2) Water supply facilities

1) As the Japanese ODA Loan project procedure was delayed for the two new water treatment plants (Shanxin Water Treatment Plant and Dapingshan Water Treatment Plant), they were constructed using national funds prior to the project. Because of the Yulin City Government's and provincial government's limited experience in aid projects, much time was spent on the approval process. As the urgency for water supply was increasing in the Shanxin and Dapingshan districts, they were to be constructed using national funds, which allows projects to be spun up more quickly. The plan was changed in March 2009 and the water treatment plants were removed from the scope of the Japanese ODA Loan project upon JICA's approval.
2) One water supply pumping station (Fumian Pump Station) was developed prior to the project in 2017 using national funds. The reason for this change is the same as 1) above, specifically to accelerate the response to the water demand. The plan was changed in March 2009, and it was removed from the scope of the Japanese ODA Loan project.
3) The water distribution pipe network was extended to 23.62 km from the planned 12 km. This is a 197% increase compared to the plan. The reason for this increase is the significant increase in the water supply area compared to the initial plan, which came with the development of the city proper. Along with the expansion of the city proper, part of the water supply target area covered by the Chengbai Water Treatment Plant, which was developed at the same time, was added to the scope of development.

Yujiang River, the water source

Chengbai Water Treatment Plant

(3) Training for the staff of the executing agency

As this project was the first construction and operation of sewage treatment facilities for Yulin City, training in Japan in cooperation with the local government of Japan was planned. However, after the commencement of this project, training in Japan was canceled because of the stricter control on overseas training in the Chinese government policy.

While training on the water supply system, budget management, water supply metering control system, leak prevention, and automatic control with regard to water supply facilities was planned, this too was canceled.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The amount of national funds used for the sewerage system for this project could not be obtained,[8] which also prevented the calculation of the total project cost.[9] Therefore, the External Evaluator compared the plan and the actual performance amounts of the Japanese ODA Loan for evaluation. The amount of the Japanese ODA Loan was changed from the initially estimated 6,282 million yen to an estimated 6,144 million yen because of the change in the scope of the project. The actual amount was 5,736 million yen, which was lower than the planned amount at 93%. This reduction in the amount occurred as a result of the scope of the project being reduced for the cancellation of one sewage pumping station, part of the piping network development, establishment of two new water treatment plants, and establishment of a new water supply pumping station.

[8] According to the executing agency, in particular the development of the part of the piping network among the scope of the project was financed by national funds as part of the governmental road development project and covers an extensive area including the part included in the scope of the Japanese ODA Loan project, which makes it difficult to accurately calculate the amount borne by the Japanese ODA Loan.

[9] The total project cost is unknown because of the inability to calculate the total project cost of the development of sewage treatment facilities. However, the executing agency confirms that the part of the sewage treatment facilities covered internally has significantly increased along with the change in the scope and the delay in the project schedule. Considering this point, it is possible that the total project cost of the entire project may have exceeded the planned one.

3.2.2.2 Project Period

This project was initially planned to run from June 2006 (L/A signing) to December 2010 (54 months). However, it actually ran from June 2006 to June 2019 (157 months, 275% of planned duration), which was significantly longer than planned. The project period for each project scope is provided below, which particularly shows the impact of the delay in the water supply system project.

Table 2: Project Period

	Plan	Actual
Overall	June 2006 to December 2010 (54 months)	June 2006 to June 2019 (157 months) 290% of planned duration
Sewerage system project	June 2006 to December 2010 (54 months)	June 2006 to September 2012 (76 months) 146% of planned duration
Water supply system project	June 2006 to December 2010 (54 months)	June 2006 to June 2019 (157 months) 291% of planned duration

Source: The plan data is based on documents provided by JICA while the actual performance data is based on responses given in a questionnaire issued to the project executing agency.

The reasons for delay are provided below.

1) Sewerage system project

The construction of the sewage plants was completed in December 2008, and a trial operation started on the same month. In contrast, the development of the sewage pipes was completed in September 2012, delayed by 18 months compared to the plan. This is due to the time spent on the redesigning and the procedure for design change when the design of a part of the sewerage piping network was changed.

2) Water supply system project

The water supply facilities underwent delay in all processes, specifically in preparation and design, bidding and procurement, civil engineering, and trial operation. The details are as follows.

Factor	Details
Redoing of detailed design	Initially unknown information on the geological characteristics and soil was detected during the preparation and design phase of the construction to divert water from the Yujiang River, causing a need to redo the detailed design and conduct a geological study. As a result, the detailed design was completed in November 2013, approximately 3 years later (35 months) than planned.
Problem in the negotiation to acquire land	The procedure for land tenancy of the part of land in Guigang, a city adjacent to Yulin City, of the land planned for diverting water from the Yujiang River, took time, and 7 years (2008 to 2015) were required to complete the negotiations. In addition to the complexity of the procedure and practices for land tenancy, changing the land to be acquired and the negotiation of compensation amount took more time than planned, resulting in a significant delay in land acquisition. This delay in land acquisition also impacted the progress of the above-mentioned geological study and led to the delay in the completion of the design phase of the project.
Delay in the project appraisal procedure	The delay in the detailed design phase caused a delay of almost 4 years in starting the bidding and procurement. The rise in prices during this period further led to a reconsideration of the project cost in December 2008, and the financing and appraisal procedure for the reconsidered project cost also took time.
Delay in the construction schedule	Because of the prolonged period from the start to the completion of the construction (2008 to 2017), the negotiation for delivery of the facilities with the construction company, which demanded additional construction payment reflecting the increase in prices during this period, did not proceed smoothly, causing a delay in starting the trial operation, which was finally conducted in September 2017. This is a delay of nearly 7 years (81 months) compared to the initial plan.

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

The financial internal rate of return (FIRR) as of the appraisal was calculated based on a project life of 30 years, with benefit calculated as utility charge revenue and the expenses calculated as project cost, operating and management cost, and maintenance cost.[10]

As a result of re-calculating the FIRR for the water supply system, the 3.3% FIRR at the time of the appraisal turned to a negative. The possible reasons behind this include the shorter benefit period due to the delay in the completion of the construction of the facilities, the increase in income tax rate after the appraisal, and the significant currency exchange rate fluctuations during the period along with a general rise in the prices.

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

[10] While the FIRR for the sewage treatment system was 2.8% at the time of the appraisal, as mentioned previously, because of the inability to calculate the total amount of the overall project cost including the domestic part, it was not possible to calculate the internal rate of return.

3.3 Effectiveness and Impacts (rating: ③[11])

3.3.1 Efficetiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

In this section, the External Evaluator confirms the degree of achievement of the project purpose; namely, to what extent "Reduction of water pollutants flowing into the Nanliujiang River and stabilization of water supply in the City" was achieved at the time of the ex-post evaluation. Specifically, quantitative effects such as the amount of water supply and the amount of sewage treatment, as well as qualitative effects such as effects of water quality improvement are evaluated mainly in terms of the indicators set at the time of planning.

(1) Sewage treatment facilities

The operation status of the sewage treatment facilities developed in this project is as follows. In 2010, this sewage treatment plant was expanded in the second phase with domestic funds, and the current treatment capacity per day was expanded from 100,000 m^3 to 200,000 m^3. As a result, all of the following indicators are actual results of the entire treatment plant including the second phase of this project, and are not accurate quantitative comparisons with planned values.

Table 3: Operation status of the sewage treatment plant

Name of indicator	Baseline	Target	Actual			
	2005	2011[12]	2012	2013	2017	2018
		1 Year After Completion	Completion Year	1 Year After Completion	5 Years After Completion	6 Years After Completion
Population connected to sewage treatment facilities (ten thousand people)	0	35	60	60	70	75
Sewage treatment capacity (ten thousand m^3/day)	0	10	20	20	20	20
Sewage treatment volume (ten thousand m^3/day)	0	10	11.9	14.2	14.4	18.8
Treatment rate (%)	0	77	88.81	100	92.31	100
Generated sludge (tons)	0	–	10,604	7,300	16,694	18,407
Sludge treatment amount (%)	0	–	100	100	100	100

Source: Responses to the questionnaire to the executing agency

1) Actual performance one year after project completion (2013) exceeded the project's targets in all indicators, including population connected to sewage treatment facilities, sewage treatment

[11] Rating for Effectiveness is to be put with consideration of Impacts.

[12] At the time of planning, the targets were set for 2011, one year after the project was scheduled to be completed. As evaluation should be implemented under the optimum operating condition of the facilities, the targets were evaluated based on the 2013 results, one year after the actual project completion.

volume, and treatment rate, which shows that sewage treatment facilities are working as expected.

2) Population connected to sewage treatment facilities at the time of the ex-post evaluation (2018) reaches 750,000 people, which exceeded twice the initial target. Yulin City has been developing its sewer network, and neighboring rural areas are added to the treatment area, which leads to an increasing demand for it.
3) As a result, average sewage treatment volume per day has reached 188,000 m^3, which is almost the upper limit of treatment capacity. The City plans to expand its capacity by an additional 150,000 m^3/day and construct a new treatment plant for industrial wastewater in order to meet the increasing demand in the future.

Table 4 indicates the effects on reduction of water pollutants and degree of achievement of national criteria for water quality by this project.

Table 4: Effects of the sewage treatment plant on reduction of pollutants

Name of indicators	Base-line 2005	Target 2011 1 Year After Completion	Actual 2009 Completion Year	Actual 2010 1 Year After Completion	Actual 2018 1 Year After Completion of the 2nd Phase Construction	National criteria B of the first-class (former criteria at the time of planning)	National criteria A of the first-class (new criteria from 2017)
BOD (biochemical oxygen demand)							
Influent quality (mg/l)	–	–	82.01	46.66	46.33		
Effluent quality (mg/l)	–	20	**9.86**	**1.11**	**0.97**	<<20 mg/l	<<10 mg/l
Reduction rate (%)	–	–	88.0%	97.6%	97.9%		
Degree of achievement	–	–	**Achieved**	**Achieved**	**Achieved**		
SS (suspended solids)							
Influent quality (mg/l)	–	–	140.24	118.75	104.42		
Effluent quality (mg/l)	–	20	**15.91**	**15.95**	**7.92**	<<20 mg/l	<<10 mg/l
Reduction rate (%)	–	–	88.7%	86.6%	92.4%		
Degree of achievement	–	–	**Achieved**	**Achieved**	**Achieved**		
T-N (total nitrogen)							
Influent quality (mg/l)	–	–	22.58	20.76	17.34		
Effluent quality (mg/l)	–	20	**14.83**	**13.79**	**11.83**	<<20 mg/l	<<15 mg/l
Reduction rate (%)	–	–	34.3%	33.6%	31.8%		
Degree of achievement	–	–	**Achieved**	**Achieved**	**Achieved**		
T-P (total phosphorus)							
Influent quality (mg/l)	–	–	2.31	2.81	1.84		
Effluent quality (mg/l)	–	1.5	**1.29**	**1.57**	**0.45**	<<mg/l	<<0.5 mg/l
Reduction rate (%)	–	–	44.2%	44.1%	75.5%		
Degree of achievement	–	–	**Achieved**	**Not achieved**	**Achieved**		

Source: Responses to the questionnaire to the executing agency

1) Reduction of pollutants has achieved the targets in almost all indicators as well as the national criteria at the time of planning. Thus, it can be evaluated that expected effects have been achieved.
2) Subsequently, because water quality criteria for sewage treatment set by the national government have become stricter, construction for improving treatment process was also carried out at this treatment plant in 2017 in order to meet the new criteria. Currently, effects of treatment have fully achieved these new criteria, and the treatment maintains good effects.
3) The fact that the sewage treatment plant has enhanced the effects of reducing pollutants by its own efforts can be appreciated as well. Yulin City's sewerage system mainly adopts a combined sewer system. Therefore, when rainwater increases, organic matter is reduced, resulting in declined treatment efficiency. To solve this problem, waste liquids containing organic matter are received from a neighboring beer factory without any charge and are utilized to enhance the efficiency of advanced treatment.

(2) Water supply facilities

Because the Dapingshan Water Treatment Plant and the Shanxin Water Treatment Plant, which were originally to be built through a Japanese ODA Loan project, were excluded, this section will mainly evaluate water supply in Yulin City Proper, including water supply population and amount of water supply. In addition, considering the situation of using the water conveyance project from the Yujiang River, effects as a Japanese ODA Loan project will be evaluated comprehensively. In addition to the Chengbai Water Treatment Plant improved by the Japanese ODA Loan project, two water treatment plants[13] are currently operating in the Yulin City Proper. The following data indicate the total of these three water treatment plants, and a strict comparison to targets will not be carried out.

1) Situation of water supply to Yulin City Proper

The status of water supply to the entire Yulin City Proper and the areas covered by the facilities by the Japanese ODA Loan project (colored area) are as follows.

[13] The Jiangnan Water Treatment Plant and the Chengtong Water Treatment Plant, whose water source is the Nanliu River, were planned to be converted to a reserved water supply facility for the Chengbai Water Treatment Plant after the completion of this project. Modifying the initial plan, the water treatment plants changed their water source and continue to supply water to the urban area. The Jiangnan Water Treatment Plant is sourced from the Yujiang River developed by this project, and the Chengtong Water Treatment Plant is sourced from Suyan Dam.

Table 5: Water supply to the urban area of the City carried out by this project

Name of indicator	Baseline 2004	Target 2011	Actual 2017	Actual 2018
		1 Year After Completion	Completion Year	1 Year After Completion
Water supplied population (ten thousand people)	29	57	–	–
Water supplied population of the urban area of the City (ten thousand people)	29	56	71.2	75.63
Among the above, area covered by Chengbai Water Treatment Plant (ten thousand people)	29	56	36.67	40
Among the above, area covered by Jiangnan Water Treatment Plant (ten thousand people)	–	–	16.61	17.1
Among the above, area covered by Chengtong Water Treatment Plan (ten thousand people)	–	–	17.92	18.53
Water supply capacity per day (ten thousand m^3/day)	9.3	26	–	–
Water supply capacity per day to the urban area of the City (ten thousand m^3/day)	–	24	23.69	23.73
Among the above, Chengbai Water Treatment Plant (ten thousand m^3/day)	–	24	15.10	15.50
Among the above, Jiangnan Water Treatment Plant (ten thousand m^3/day)	–	–	3.69	3.95
Among the above, Chengtong Water Treatment Plant (ten thousand m^3/day)	–	–	4.90	4.28
Average daily quantity of water intake of Chengbai Water Treatment Plant (ten thousand m^3/day)	–	–	13.15	13.67
			3.15	3.67
Among the above, quantity of water intake from Yujiang River			10	10
Among the above, quantity of water intake from the existing water source (Suyan Dam)				
Average daily water supply (ten thousand m^3/day)	–	–	–	–
Average daily water supply to the urban area of the City (ten thousand m^3/day)	–	–	21.55	21.57
Among the above, Chengbai Water Treatment Plant (ten thousand m^3/day)	–	–	13.00	13.50
Among the above, Jiangnan Water Treatment Plant (ten thousand m^3/day)	–	–	3.65	3.8
Among the above, Chengtong Water Treatment Plant (ten thousand m^3/day)	–	–	4.90	4.27

Coverage of the water supply system (%)	59	91	–	–
Coverage of the water supply system in the urban area of the City (%)	72	100	100	100
Among the above, Chengbai Water Treatment Plant (%)	72	100	100	100
Among the above, Jiangnan Water Treatment Plant (%)	–	–	100	100
Among the above, Chengtong Water Treatment Plant (%)	–	–	100	100

Source: JICA technical appraisal report, responses of the questionnaire to the executing agency

1. In one year after project completion in 2018, coverage of the water supply system[14] in the Yulin City Proper reached 100% and water supplied population[15] in the City reached 756,300 people. Water supplied population, which is covered by the Chengbai Water Treatment Plant improved in this project as well as the Jiangnan Water Treatment Plant using the channels of the Yujiang River, totaled 571,000 people,[16] exceeding 560,000 people at the time of planning. This accounts for 75% of the water supplied population of the entire City.
2. Water supply capacity per day to the urban area of the City has almost reached the target, 240,000 m^3/day, and the target of water supply is almost achieved. Quality of supplied water also meets the national criteria and no major problems have been observed. However, in the Chengbai Water Treatment Plant, average daily water supply and water supply capacity per day are 56% and 68% of the planned capacity, respectively, and the water supplied population and water supply capacity of the water treatment plant itself have not achieved its initial plan.
3. Reason for this includes an optimized water supply system. The Jiangnan Water Treatment Plant and the Chengtong Water Treatment Plant, which were scheduled to be converted to reserved water supply facilities, are now fully operational along with the expansion of the city proper. As a result, it is considered that the assumed water supply area covered by the Chengbai Water Treatment Plant at the time of planning shrank, reducing the water supplied population to be covered.
4. The area where water is supplied by the Chengbai Water Treatment Plant is expected to expand further, because a part of Beiliu City adjacent to Yulin City will be merged into Yulin City.

[14] Coverage of the water supply system is defined as a proportion of water supplied population to population living in the water supplied area.
[15] Water supplied population is defined as a population that actually receives water supply by connecting water pipes.
[16] Because the Jiangnan Water Treatment Plant started water intake from the Yujiang River in 2018, values of 2018 and beyond are used as indicators.

Based on the above, at the time of the ex-post evaluation, the purpose of this project, developing a sewage treatment system in the urban area of the City has been mostly achieved, while the operational status of the Chengbai Water Treatment Plant built using a Japanese ODA Loan has not yet reached the plan. Water supply is likely to increase further in the future, but the overall effect of the water supply system project is evaluated as being fair.

2) Water conveyance project from Yujiang River

As mentioned in "3.1.4 Appropriateness of the Project Plan and Approach," water conveyance volume from the Yujiang River remains at only about 40% of the original plan as of 2018. The three water treatment plants supplying water to the city proper take in water from the existing Suyan Dam as the main water source, and the Chengbai Water Treatment Plant also takes in more than 70% of the whole water from the existing Suyan Dam.

1. Besides low cost of water intake, the main reason was that as full-scale operation of the water conveyance project delayed to the year 2017, it is still under adjustment period for operation. Currently, the water from the Yujiang River is conveyed to the Chengbai Water Treatment Plant and the existing Jiangnan Water Treatment Plant, from which water is supplied to the city proper. Current water supply to city proper is about 70,000 m^3, and is gradually increasing.
2. In the initial plan, it was planned to supply a part of 250,000 m^3/day of water conveyance volume from the Yujiang River to neighboring cities and rural areas. At the time of the ex-post evaluation, as shown in the table below, in addition to the initially planned Qiaoxu Township and Shinan Township of Guigang City, a plan is underway to sell raw water to four townships by 2020. Water supply to some areas has already started.

Table 8: Future prediction of water conveyance from Yujiang River to urban areas and other townships

Estimated average water supply volume per day	Period to start supplying	2019	2020	2021	2022	2023
Total (ten thousand m^3/day)		**6.79**	**11.16**	**13.70**	**16.30**	**19.90**
Urban area of the City	Has already started	4.00	5.00	6.50	8.80	12.00
Qiaoxu Township (Guigang City)	Has already started	1.00	1.97	2.50	2.70	3.00
Zhanjiang Township (Guigang City)	Has already started	0.29	0.60	0.70	0.80	0.90
Shinan Township (Yulin City)	Made a contract (Scheduled to start from July 2019)	1.50	3.00	3.00	3.00	3.00
Xingye County Industrial Park (Yulin City)	From June 2020	0.00	0.58	1.00	1.00	1.00

Source: Responses to the questionnaire to the executing agency

Over the next five years, total water supply is anticipated to increase to approximately 200,000 m^3, which amounts for about 80% of its water conveyance capacity of 250,000 m^3, and is expected to achieve a favorable utilization.

In summary, the sewerage system project has almost achieved its plan. On the other hand, although the water supply system project has almost achieved its objective of stabilizing water supply to the urban area of the City, the water conveyance project of the Yujiang River has just started partial utilization because of delays in development of facilities. Considering this point, effectiveness of the water supply improvement project including the water conveyance project at the time of the ex-post evaluation is evaluated to be still fair. However, as it has been confirmed that there is a high possibility of facilitating full-scale utilization in the next two to three years, the overall effectiveness of this project is evaluated to be high. It is desirable to monitor the future progress on a regular basis to confirm whether the operation status of the entire system including the water conveyance project advances as expected.

3.3.1.2 Qualitative Effects (Other Effects)

Refer to Section 3.3.2 “Impacts.”

3.3.2 Impacts

3.3.2.1 Intended Impacts

In this project, “improvement of living environment of residents of Yulin City” is regarded as an impact. Specifically, the External Evaluator analyzed “improvement of water environment” and “improvement of residents' convenience and satisfaction/improvement of living environment through improvement of water environment” by developing water supply and sewerage systems in this project as specific impacts.

(1) Improvement of water environment

1) Monitoring data at the observation points of the Nanliujiang River

The following data indicate the change of water quality at the observation points of the Nanliujiang River that discharges treated sewage and the Qingwanjiang River that flows into the Nanliujiang River. The lower point of Yulin City serves as the lower observation point of the Nanliujiang River that is closest to the sewage treatment plant. The river water quality is affected by the degree of pollution in the upper area of the river, and the amount of water treated by the sewage treatment plant is very small compared to the amount of river water of the Nanliujiang River Therefore, as it is difficult to clearly examine the relationship with this project, the External Evaluator analyzes the contribution of this project qualitatively.

Table 9: Water quality of Nanliujiang River

Observation section	Observation year	PH	SS (mg/m^3)	COD (mg/m^3)	BOD (mg/m^3)	T-P (mg/m^3)
In front of city where water flows into Nanliujiang River	2002	7.43	–	–	–	–
	2018	7.24	3.02	15.01	0.51	0.47
Upper point of Nanliujiang River	2002	7.66	–	–	–	–
	2018	7.52	3.82	18.8	0.82	0.34
Middle point of Yulin City (Nanliujiang River)	2004	7.42	29	51.33	17	0.021
	2018	7.36	4.01	30.65	1.38	0.65
Lower point of Yulin City (Nanliujiang River)	**2004**	**7.57**	**29**	**48.67**	**7**	**0.594**
	2018	**7.34**	**5.11**	**17.81**	**1.21**	**0.38**
	Compared to 2004	**-3%**	**-82%**	**-63%**	**-83%**	**-36%**
In front of city where water flows into (Qingwanjiang River)	2004	7.2	22.33	5.67	1.1	–
	2018	7.17	2.85	11.24	0.85	0.21
In the city (Qingwanjiang River)	2004	7.34	41.67	33.33	3.93	0.64
	2018	7.23	3.96	13.41	1.32	0.21

Source: data for 2002 and 2004 at the time of the appraisal were retrieved from the technical appraisal report, and observed data for 2018 were provided from the executing agency

1. At the observation section adjacent to the sewage treatment plant developed by this project, a decrease in concentration of major water pollutant of greater than 50% was confirmed. It shows that river water quality has an improving tendency in general.
2. By calculating total amount of reduced water pollutants by this project based on the annual treatment amount by the sewage treatment plant, a reduction effect of 311 kg in BOD and 2,020 kg in COD can be estimated according to the results of 2018. These reductions can be evaluated as contributing to some extent to improving river water quality and curbing its deterioration.

(2) Improvement of residents' convenience and satisfaction/improvement of living environment through improvement of water environment

1) Result of the interviews with beneficiaries

To grasp recognition and evaluation of beneficiaries about the "improvement of water environment," interviews[17] were conducted with residents of Yulin City and real estate companies in the City. Then, the following were examined: water environment, improvement in residents' convenience and their living environment, as well as changes in river environment before the project implementation (2006) and at the time of the ex-post evaluation (2018). Examples are summarized below.

[17] In the interviews, a group discussion was conducted with eight participants from a property management company, a water supply company, a real estate developer, and retired workers (seven men and one woman), to confirm changes in water environment and its effects on their lives. Interviewees were selected in the cooperation with the executing agency.

1. Improvement in residents' convenience and their living environment: Several comments were found that comfort with domestic water use such as the stabilization of water pressure by improvement of water supply has been increased. One respondent said, "Before development of this project, low water pressure hindered convenience of our living such as using showers only at night when the amount of water use got lowered, but now water pressure is stable and we can use water at any time." Another respondent (real estate agent) said, "Previously, low water pressure induced frequent suspension of water supply at the 3rd floor or above, limiting housing development to low-rise housing. However, development of water supply allowed building of high-rise houses." From the comment, it can be assumed that development of water infrastructure facilitated real estate development and urban development.

2. Changes in water environment/river environment: Some respondents recognized the effects of improvement of health and increased time for enjoying leisure at rivers by water quality improvement. According to a respondent, well water was used until around 2007, but very high ammonia nitrogen led to safety issues, and many people had suffered from diseases such as throat irritation and hepatitis. After development of this project, tap water quality has reached the level allowing use, which greatly improved these issues. One respondent is able to enjoy fishing because water quality of the river has improved, odor and turbidity have been reduced, and the riverbed has been improved.

The results of the interview above, in spite of a limited sample, show that many respondents stated that stabilization of water brought about effects such as improvement of housing conditions. Therefore, it can be inferred that overall satisfaction with current water supply environment has increased.

3.3.2.2 Other Positive and Negative Impacts

(1) Antipollution measures

At the time of planning, sludge discharged from the sewage treatment plant was to be disposed at the existing landfill site. Although the plan has not greatly changed for now, sludge is dehydrated and disposed at the existing landfill site, or it is sometimes transported to a fertilizer factory for reuse.[18] As mentioned in the section of Effectiveness, the generated sludge is 100% treated and there are few negative environmental impacts.

[18] At present, investigation on hazardous substances such as heavy metals has not been carried out, but within the scope of confirmation during the field survey, no machinery, electrical, or electronics factories where heavy metals are used were founded in the covered area. It is therefore considered that there are no major concerns.

Sludge treatment

Truck for taking out sludge

(2) Impacts on the natural environment

At the time of appraisal, this project was classified as Category B of *the JBIC Guidelines for Confirmation of Environmental and Social Considerations* (April 2002) and was judged to have no undesirable and significant impact on the environment. The Yujiang River, the source of water intake, has abundant water. Therefore, any impacts on the natural environment/ecosystem due to water intake are unforeseen. Moreover, it is considered that advanced treatment in sewage treatment can minimize the environmental impacts on the river where treated water is discharged. No environmental protection areas exist in the area covered by this project and its neighboring area. In addition, no issues that had not been envisaged in the EIA report were found at the time of the ex-post evaluation.

(3) Impacts on the social environment

1) Resettlement and land acquisition: No resettlement caused by this project has been carried out. As for land acquisition, 13 ha was planned to be acquired in total for water supply and sewerage systems, and the area actually acquired was about 12.4 ha,[19] which was a slight decrease from the plan. This is because a part of the planned site for a sewage pumping station was designated as a relocation site of residents in development plan of the City, thereby shrinking the site for the pumping station. It took about seven years to reach an agreement on all land acquisitions, and nine years to complete payment. Because of the rise in land prices during this period, the acquisition cost amounted for about 50 million yuan (about 685 million yen), a 160% increase from the plan.
2) Difficulties in negotiations on land acquisition: It can be assumed that careful proceedings of the land acquisition process paradoxically required more time than expected. As stated in the section of efficiency, it was difficult to negotiate on compensation with farmers in the land acquisition of the water supply facilities. Although the compensation amount

[19] The breakdown is 7.23 ha acquired for sewage treatment facilities and 5.15 ha for water supply facilities.

initially presented to the target people was in accordance with the national criteria, the farmers did not agree with the amount and the negotiations were prolonged. Eventually, the negotiations reached an agreement that an infrastructure development project in the target area would be carried out in addition to the compensation. In addition, a part of the planned site for a channel is located in neighboring Guigang City, and the administrative organization of Guigang City was mainly in charge of negotiations on acquisition of the land in the City. As a result, it took time to coordinate between the two cities as well as to confirm the agreement.

As described above, this project has achieved expected outcome in general. However, due to the partial delay of construction work, outcome of the project is still in the process of emergence. Therefore, effectiveness and impacts at the time of the ex-post evaluation are fair, though it is expected to achieve high effectiveness in the near future.

3.4 Sustainability (Rating: ③)

3.4.1. Institutional / Organizational Aspect of Operation and Maintenance

At the time of the planning of this project, the Yulin People's Government was supposed to be in charge of the entire project. The Finance Bureau of the city government and the Environmental Protection Bureau were supposed to be in charge of monitoring the finances and environmental aspects, respectively. Currently, the operation and maintenance system has not been greatly changed. The operational management system in the water supply and sewerage system project is as follows.

(1) Sewage treatment facilities

In accordance with its plan, the operation and maintenance of sewage treatment facilities is carried out by "Yulin City Meirin Sewage Treatment Limited Liability Company" under the umbrella of state-owned company "Yulin City Urban Construction Investment Group Limited Company." The company consists of six sections, including the Facilities Maintenance Section, Production Management Section, and Pipeline Maintenance Section, with 59 employees. Among them, 51 employees are engineers, who are properly assigned. There is no problem of shortage in labor.

(2) Water supply facilities

In accordance with its plan, a state-owned company "Yulin Water Supply Company" is responsible for the operation and maintenance of the water supply improvement project. Yulin Water Supply Company consists of three water treatment plants, three pumping stations, and

fourteen sections, including the Pipeline Operation and Maintenance Office, the Water Supply Section, and the Manufacture Technology Management Section. The company has been granted patent management rights by the Yulin People's Government and has received an entrustment from the City to operate the services. Yulin Water Supply Company has a total of 400 employees, including 50 to 60 employees at the Chengbai Water Treatment Plant.

3.4.2 Technical Aspects of Operation and Maintenance

(1) In both water supply and sewerage systems, technologies and specifications of introduced facilities have already been established in China. The staff members in charge, who have national qualifications required for each process with practical experience, have been assigned. Therefore, no major concern on technical aspects of operation can be found.

(2) Experts in sewerage system projects participated in the field survey to interview staff members in charge. The staff members gave appropriate responses such as knowledge and experience of treatment technologies and how to handle problems that may occur. In addition, manuals for operation, maintenance, and inspection are prepared in both water supply and sewerage systems, so that people in charge at each facility can always confirm. The records of periodic inspections were reviewed as well; the records are found to be properly managed in all facilities and there are no problems with management capability.

(3) With regard to human resource development, training for employees has also been institutionalized. Because an environment has been prepared in which employees can take training courses in the autonomous region, it can be evaluated that there are no major technical problems.

3.4.3 Financial Aspect of Operation and Maintenance

(1) Sewage treatment facilities

"Yulin City Meirin Sewage Treatment Limited Liability Company," which operates sewage treatment facilities, does not collect sewerage charge directly; instead, the government provides the company a grant as annual revenue. Current revenue and expenditures are as follows.

Table 10: Financial status of sewage treatment plants

Item	2015	2016	2017
1. P/L indicators			
Revenue (Unit: Thousand Yuan)	17,335	17,681	18,366
Expenditure (Unit: Thousand Yuan)	17,379	17,678	18,085
Operating profits (Unit: Thousand Yuan)	**-44**	**3**	**281**
Operating profit margin (%)	-25.5%	0.016%	1.5%
2. B/S indicators			
Capital adequacy ratio (%)	21.99	19.16	21.05
Current ratio (%)	196.2	150.6	–

Source: Prepared based on responses to the questionnaire

Although the plants had run a slight deficit in 2015, it turned into a single-year surplus due to lowering administrative costs from 2016, and since then the plants have recorded profits. The sewerage charge at the time of the ex-post evaluation was set at 0.95–1.4 yuan/m^3, and has been raised from 0.82 yuan/m^3 at the time of the appraisal. The sewerage charge is controlled by the Price Bureau of the Autonomous Government, and the current price is set at a level that barely maintains the soundness of service operations. Despite its low profitability, the service operation is based on the government budget, and no major problems have occurred in financial management.

(2) Water supply facilities

1) Water supply services

According to the water company that operates the water supply facilities, the water supply services have introduced an independent profit system and no subsidy has been received from the government. The recent profit and loss statement is as follows.

Table 11: Financial status of the water supply facilities

Items	**2015**	**2016**	**2017**	**2018**
1. P/L indicators				
Operating revenue (Thousand Yuan)	115,271	118,733	124,086	148,761
Operating costs (Thousand Yuan)	89,401	84,681	101,208	145,370
Operating profits (Thousand Yuan)	30,716	34,357	23,183	3,684
Operating profit margin (%)	26.65%	28.94%	18.68%	2.48%
Net profit (Thousand Yuan)	27,024	30,163	20,142	4,197
2. B/S indicators				
Capital adequacy ratio (%)	30.34%	36.61%	38.18%	37.97%
Current ratio (%)	707%	761%	136%	129%

Source: Prepared by the External Evaluator based on data provided by the executing agency

1) From 2015 to 2017, very high operating profits were yielded at 20–30%. According to the executing agency, the results were brought by sales such as water pipe connection work and sales of installed devices, in addition to revenue from water charge. It can be estimated that 2018's operating profit margin of about 2.5% reflects usual profitability of water supply services. The capital adequacy ratio has also been kept at nearly 40%, and it can be said that a sound financial footing has been generally maintained.
2) Expansion of water supply area brought about steady growth of the revenue from water charge, and operating revenue in 2018 greatly increased by 14% year-on-year.
3) Water charge is set by the autonomous government in consideration of profitability. The water charge at the ex-post evaluation was raised from 1.55 yuan/m^3 at the time of the appraisal to 2.3–4.49 yuan/m^3. Currently, the standard rate for general households is 2.3 yuan/m^3, and the water supply cost per m^3 is about 1.8 yuan/m^3. Therefore it can be evaluated that profitability in service operation is secured.
4) As mentioned in the section of Effectiveness, the water company sells water from the Yujiang River to other townships and Guigang City, and the water conveyance volume is expected to grow significantly in the future. Revenues from these above are also expected to become a stable financial source for future operation and maintenance.

3.4.4 Status of Operation and Maintenance

(1) Sewerage system project

The operation and maintenance of sewage treatment facilities are generally carried out appropriately, and no serious problems have been confirmed. Annual maintenance cost is 2.07 million yuan (approximately 34.36 million yen), and repairs are carried out regularly. Japanese experts in sewerage system projects also participated in the tour of the facilities, and confirmed the following two points regarding the durability and operational issues of the facilities.

・ Damaged coarse screen: The coarse screen[20] prepared with the Japanese ODA Loan was damaged two years after installation and was replaced with other equipment. The experts in sewerage system projects who attended the field survey point out that the installed screen was inexpensive and may have had low durability, and that it was installed at a narrow and steep slope, resulting in the screen being subjected to overload more than expected. Equipment replacement is carried out quickly and no operational problem occurs, but periodic replacement may be necessary in the future.

・ Deterioration of outdoor facilities (aeration tank, settling tank): Deterioration of foundations (concrete structures) of outdoor facilities became noticeable. According to the opinion of the

[20] A device that removes large garbage items and floating matter flowing into a sewage treatment plant

attending experts, in addition to air pollution such as acid rain, there may be other factors such as issues on the quality of the material and insufficient frequency of coating[21] as well. According to the executing agency, regular painting work is planned. Therefore, if the work proceeds as planned, it can be considered that durability of the facilities will not be significantly affected. However, if the deteriorated part were abandoned, the durable life of the facilities might be shortened. Therefore, regular maintenance should be appropriately planned and carried out as planned.

Damaged coarse screen

Deteriorated part of concrete structures

(2) Water supply system project

Because the water supply facilities have been recently completed, the operation status and facilities are in good condition. Management is carried out in accordance with the safety management manual, and no problems are found. The water supply pumping station also has stable operation hours, and no major failure has occurred in the electrical facilities. A system of replacing parts as well as their suppliers in case of failure have been established. It is reported that water pipes and water distributing pipes are normal in all sections.

Both water supply and sewerage systems are already common infrastructures in China, and the system for maintaining this project and conducting the sewage treatment services has been prepared with regard to technology, finance, and current state. In terms of management of facilities, deterioration of the fundamental structures of sewage treatment facilities was observed, but there was no serious concern because a repair plan has been formulated at this time. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned, and Recommendations

4.1 Conclusion

This project was conducted for the purpose of reducing water pollutant emissions and supplying water safely and stably to improve the living environment of the local residents by establishing clean water infrastructure and sewage treatment facilities in Yulin City, Guangxi

[21] Lime is used for coating because of its inexpensiveness.

Zhuang Autonomous Region. The relevance of this project is high because of its conformity with the Japanese government's policies and needs as well as Chinese policies and needs. While the scope of the project has been revised and the period has been extended, the infrastructure has been established mostly as planned, and thus the efficiency of this project can be evaluated as fair. Since the implementation of this project, the water supply and sewage infrastructure has been operating satisfactorily, with highly effective reduction of water pollutants through the construction and operation of sewage treatment facilities. The water supply system has also been operating steadily, responding to the increasing demand and providing a stable water supply to the local residents. The expansion and improvement of the water and sewage infrastructure are still ongoing. Additionally, the responsible organizations have been structured with stable foundations with regard to technology and finances, which indicate good sustainability. In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Improvement of the maintenance plan for sewage treatment facilities

In sewage treatment facilities, external appearance of outdoor facilities was deteriorated and some equipment malfunctioned. The malfunctioned equipment is inexpensive but has a problem in terms of durability. It is necessary to continue regular maintenance and keep the frequency of repairment in the future. In addition, it can be assumed that major causes of deterioration of external appearance of outdoor facilities include painting with low-cost lime, air pollution, and acid rain. Thus, it is desirable to strengthen the maintenance and inspection system in order to keep the durable life of the facilities, such as using corrosion-resistant materials and improvement of maintenance frequency.

4.2.2 Recommendations to JICA

Nothing in particular.

4.3 Lessons Learned

Improvement of accuracy of the Project Plan and Approach

The operation rate of the water conveyance project developed by this project is only about 40% of the initial plan. This is due to factors such as the ability to secure a greater quantity of water intake of the existing water source than in the initial plan, as well as significantly increased water intake cost from the time of planning. This means that these possibilities might not have been fully examined at the project planning stage. In the future, in addition to the initially expected water supply for the city proper, needs for water supply to the area along the channel are expected. If accurate examination of needs and alternatives means had been

conducted throughout the project planning period, effects on the entire durable life of the facilities could have appeared much earlier, such as preferential supply to the area along the channel where water can be supplied at a lower cost.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs		
1) Sewer network improvement	156 km	Almost as planned (153.76 km)
2) Sewage pumping stations	Newly built 2 stations	Newly built 1 station
3) Sewage treatment plant	Newly built 1 plant 100,000 m^3/day	As planned
4) Water supply channel	75 km	Almost as planned (72.02 km)
5) Water supply pumping stations	Newly built 4 stations	Newly built 3 stations
6) Water treatment plant (newly built)	Newly built 2 plants	Canceled
7) Water treatment plant (extended)	Extended 1 plant 10,000 m^3/day → 27,000 m^3/day	As planned
8) Training	Training in Japan regarding water and sewage operations, targeting the staff of the executing agency	Canceled
2. Project Period	June 2006–December 2010 (54 months)	June 2006–June 2019 (157 months) 290% compared to the planned period
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	6,644 million yen 6,792 million yen 13,436 million yen 6,282 million yen 1 yuan = 13.7 yen (As of September 2005)	5,736 million yen Cannot be calculated[22] Cannot be calculated[23] 5,736 million yen 1 yuan = 15.13 yen (Average exchange rate from 2006 to 2017)
4. Final Disbursement	October 2015	

[22] According to the executing agency of development projects for sewage treatment facilities, the cost of the construction of the drainage pipe network among the project scope was spent as part of a road improvement project by the government. The section to be improved was more extensive, including the Japanese ODA Loan project. Thus, it could not be calculated because it was difficult to calculate the accurate amount allocated to the sewage treatment facilities maintenance project.

[23] For the reason mentioned above, the total cost of this project including water supply and sewerage systems could not be calculated.