People's Republic of China

FY2018 Ex-Post Evaluation of Japanese ODA Loan

Ningxia Hui Autonomous Region Urban Water Environment Improvement Project

External Evaluator: Kenji Momota, IC Net Limited

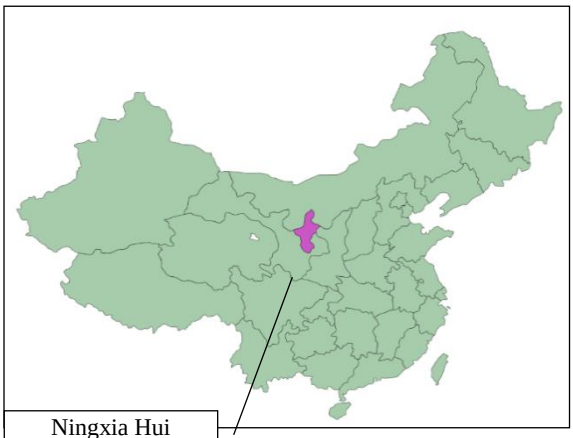
0. Summary

This project was implemented to secure a stable and safe water supply and to reduce the discharge of water pollutants by building water supply and sewerage facilities and reclamation facilities (Reuse of treated sewerage water) in Yinchuan City and Shizuishan City in the Ningxia Hui Autonomous Region, thereby contributing to the improvement of the living environments for residents of in both cities.

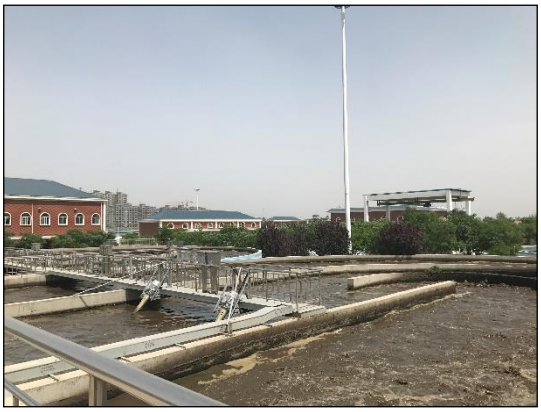
This project is in line with the policies and needs of the Japanese and Chinese governments and is relevant in general. However, as for Shizuishan City, the project outputs and effects deviated from the project plan along with stagnation of urban development, and there was possibly a problem with the accuracy of the project plan at the time of the appraisal and project management. Regarding the project outputs, facilities were built as planned in general, although changes were made and the period extended because of substitute improvements based on domestic funds. The project cost was lower than planned but the project period was significantly longer than planned; thus, the efficiency of the project was fair.

Regarding the resulting effects of this project, there is a contrast between Yinchuan City and Shizuishan City. Satisfactory results were accomplished in Yinchuan City, whereas the results in Shizuishan City were less satisfactory because the water supply work was not accomplished as planned owing to population decrease in the targeted areas, and the sewerage facilities are barely in operation. Thus, the effectiveness of this project is evaluated as fair. Regarding the operation and maintenance, for both cities, there are no problems with the structure of the organization in charge and technical and financial aspects. However, in Shizuishan City, a situation with no chance of using the facilities, especially sewerage and reclamation facilities, has continued, and thus there seems to be some problems with sustainability. Based on the above, this project is evaluated as partially satisfactory.

1. Project Description



Project Location Map


Sewerage Treatment Plant Built under This Project (Yinchuan City)

1.1 Background

The Ningxia Hui Autonomous Region, which is located in the Ningxia plain in the upstream of the Yellow River in China, is in an arid zone and considered one of the regions facing the most severe water shortage. In its major cities, Yinchuan City and Shizuishan City, the water demand due to industrialization and urbanization increased and exceeded the existing supply capacity in 2007. Areas without water service were facing excessive pumping of groundwater due to the increased number of shallow wells built. In addition, the sewage drainage volume exceeded the city's treatment capacity, and wastewater from houses and plants flowed without treatment into rivers in the city and the underground, worsening water, soil, and groundwater pollution. Given this situation, the Chinese government tightened the control of water resources, such as strengthening of the regulations on private wells , developing new groundwater resources, and promoting of use of reclaimed water, in order to promote overall improvement of water environments through water pollution measures based on improvement of the wastewater treatment capacity.

1.2 Project Outline

The objective of this project is to secure a stable and safe water supply and to reduce the discharge of water pollutants by building water supply and sewerage facilities and reclamation facilities in Yinchuan City and Shizuishan City in the Ningxia Hui Autonomous Region, thereby contributing to the improvement of the living environments for residents of both cities.

Loan Approved Amount/ Disbursed Amount	8,432 million yen/8,368 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2007/March 2007

Terms and Conditions	Sewerage treatment facility: General untied loan, at 0.75% interest, redemption period of 40 years, deferment period of 10 years Water supply facility: General untied loan, at 1.5% interest, redemption period of 30 years, deferment period of 10 years Training: General untied loan, at 0.75% interest, redemption period of 40 years, deferment period of 10 years
Borrower / Executing Agency	People's Republic of China/Ningxia Hui Autonomous Region Administrative Agency
Project Completion	September 2015
Main Contractor (Over 1 billion yen)	NINGXIA COAL BASIC CONSTRUCTION CO., LTD (People's Republic of China)
Main Consultant (Over 100 million yen)	None
Related Studies (Feasibility Studies, etc.)	F/S: Created by the Academy of Architectural Design for Plans of Yinchuan City and Shizuishan City in China, on June 2005
Related Projects	None

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 – March 2020

Duration of the Field Study: May 12–30, 2019; October 9–17, 2019

2.3 Constraints during the Evaluation Study

In this project, collection of data and information for some items was not sufficient, especially for relevance. Regarding Section 3.1.4 Appropriateness of the Project Plan and Approach, it was not possible to make contact with government officials concerned with Shizuishan City at the time of the appraisal and responsible people involved in the project plan owing to reasons such as retirement and staff turnover, and there were not enough opportunities for discussion, although arrangements were attempted. Much of the information concerning relevance was not recorded in documents, and there was no choice but to analyze the details at that time according to limited estimations. This difficulty is significant because it affects the entire evaluation; in fact, it affected not only the relevance but also the evaluation of effectiveness and sustainability.

3. Results of the Evaluation (Overall Rating: C[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

1) **National level** In the *11th Five-Year Plan (2006–2010)*, the Chinese government set goals of strengthening efforts to secure water resources for cities with a severe water shortage, improving the water supply capacity through extension and upgrading of water service facilities, securing safe drinking water, and saving water resources by reducing the rate of leakage. The *National 11th Five-Year Plan for Environmental Protection (2006–2010)* set a goal of improving the water quality of the Yellow River, designated as a high-priority protection basin, to the level of drinking water. In the *11th Five-Year Plan (2001–2005)*, the goals of the sewerage sector were to achieve a sewerage treatment rate of 70% in urban areas, improve the water quality of water resources through implementation of a comprehensive set of measures in the middle and upper basin of the Yellow River, and promote pollutant reduction measures such as introduction of a system to collect the cost for pollutant emissions.
2) **Provincial level** The government of the Ningxia Hui Autonomous Region formulated the *11th Five-Year Plan for Ecological Construction and Environmental Protection in Ningxia Hui Autonomous Region (2006–2010)*, the goals of which were to ensure that 100% of drinking water in urban areas meets the water quality standards and the sewerage treatment rate reaches 70% by the year 2010. The *Elements of Water Saving Society Construction Plan for Ningxia (2004–2020)* was designed, because of increasingly severe water shortages due to economic development and population increase along with industrialization and urbanization, to produce reclaimed water with the use of technology that reuses treated waste water and build a water-saving society that strives to reduce the amount of clean water usage.

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

1) **National level** The *13th Five-Year Plan for National Environmental Protection (2016–2020)* states that all water supply processes from water sources to faucets will be managed to improve the water quality of drinking water. This plan made it obligatory for local governments and water supply utilities to regularly inspect and evaluate the water quality of drinking water sources, treated water from water purification plants, and water for supply, and set a goal of ensuring that, for the concentrated drinking water sources in urban areas, the ratio of water quality Class I to III[3] exceeds 93% by the year 2020. The plan also states

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

[2] ③: High, ②: Fair, ①: Low

[3] River water qualities are classified into five classes (Class I to V) according to the Surface Water Environmental Quality Standards (GB3838-2002). Class I: Mainly water of water resources. National nature reserve; Class II: Mainly drinking water for household use. Class A reserve. Rare fish species reserve. Spawning grounds for fishes and

clearly that the government will build a water-saving society to protect the environment, with goals of developing counties and cities that serve as a resource recycling economy model, spreading new billing methods such as water billing based on smart metering, and strengthening the accountability for producers. The objective in the sewerage field is that for national surface waters, the ratio of water quality Class I to III will exceed 70%, and it was declared that by the year 2020, sewerage treatment facilities will be built for all of the towns in which a county government is located and the towns with high priority, with the target of achieving a sewerage treatment rate of around 95% and 85%, respectively.

2) **Provincial level** The *13th Five-Year Plan for Ningxia Hui Autonomous Region (2016–2020)* sets out a vision to promote water conservation and efficient water use management in order to resolve water resource constraints, a bottleneck for social and economic development. This plan states clearly that the government will build a water-saving society model through comprehensive use of water, including recycled water (reclaimed water). The government is working on consideration of an ordinance that makes it mandatory for some business operators to use reclaimed water and water-saving campaigns for residents. Yinchuan City and Shizuishan City prohibit excessive extraction of groundwater and are committed to working toward improving rivers through the promotion of sewerage systems.

3) **Municipal level** The *13th Five-Year Plan for Yinchuan City (2016–2020)* recognizes the achievement of the water quality standards for major rivers but still recommends living a daily life as a consumer who is environmentally conscious for sustainable development, and plans water resource development projects in addition to water resource uses such as the storage of rainwater, effective use of Yellow River water resources, protection of groundwater, and diversification of water. The *12th Five-Year Plan for Shizuishan City (2010–2015)* still gave priority to water resource management but set out a new policy to transform the urban development model into a more comprehensive one with emphasis on the replacement of coal with new energy. This policy caused coal business and other related businesses with large amounts of water usage to move to other provinces, drastically reducing the number of companies and people, which had a significant impact on the project scope and effects to be mentioned later. Subsequently, the *13th Five-Year Plan for Shizuishan City (2016–2020)* set a goal of ensuring that the rate of achieving the water quality standards for drinking water is 100%, the rate of achieving the water quality Class III for the basin of the Yellow River is 100%, and the sewerage treatment rate is 85%.

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shrimps; Class III: Mainly drinking water for household use. Class B reserve. General fish species reserve. Swimming area; Class IV: Mainly water for industrial use. General industrial water area. Area of recreational water with no direct contact with a human body; Class V: Mainly water for agricultural use. Agricultural water area. Applied to general landscape conservation.

As seen above, from the time of the appraisal to ex-post evaluation, the policies in the water supply and sewerage sector put emphasis on securing safe drinking water and saving water resources; no significant change is seen in those policies. This project is meant to construct new treatment facilities for water supply, reclaimed water, and sewage in Yinchuan City and Shizuishan City, where there are restrictions on the use of surface water and groundwater, thereby expanding the overall treatment capacity of the cities. The project is highly consistent with the Chinese government's development policies, where the priority areas include reduction of pollutants and improvement of water environments.

3.1.2 Consistency with the Development Needs of China

(1) Situation at the time of the appraisal

The Ningxia Hui Autonomous Region has an annual precipitation of 200 mm, which is less than the national average of 585 mm. In addition, the amount of domestic water use per person per day is 110 L, which means that water use is limited to half the national average, with severe water shortages. At the time of the appraisal, the water supply-demand balance of Yinchuan City and Shizuishan City was such that the demand was two to three times the supply capacity and the shortage was dependent on development of a private well. The water demand increased further owing to rapid social and economic growth at that time, and it was feared that the groundwater sources would be depleted if things continued as they were. Under this environment, both cities were working mainly on improvement of the existing water supply facilities and spread of water-saving technologies for efficient use of water resources. For the Ningxia Hui Autonomous Region with scarce water resources, the necessity of replacing clean water demanded by plants and other facilities with reclaimed water was high, and at the time of the appraisal, reclaimed water was used for greening, plant use, and other purposes. In the case of Yinchuan City, the forecast of demand for reclaimed water in 2010 was 150,000 m^3/day, including the prospect of using the thermal power station under construction, whereas Shizuishan City predicted that the demand would grow to 138,000 m^3/day, in expectation of demand for use in thermal power stations, cement factories, chemical plants, etc.[4]

The amount of domestic wastewater also increased with increasing water demand. In 2005, the amount of wastewater in Yinchuan City and Shizuishan City was 288,000 m^3/day and 185,000 m^3/day, respectively, both of which greatly exceeded the treatment capacity. The untreated water was discharged directly into the Yellow River, and water pollution was becoming more serious; for example, a red tide occurred 82 times in 2005.

[4] Source: Provided by the executing agency, Yinchuan City Architectural Design and Planning Co., Ltd. (2005).

(2) Situation at the time of the ex-post evaluation

Currently, the needs of securing safe water and preparing sewerage systems are still the same. The total population of Yinchuan City in 2018 was 2.25 million, up about 40 percent compared with 2007 (1.617 million people); the demand for clean water was 900,000 m^3/day, 1.5 times higher than the supply capacity (600,000 m^3/day), and the demand for sewerage systems was 600,000 m^3/day, which also exceeded the treatment capacity of 500,000 m^3/day.

At the time of the appraisal, regarding the total population of Shizuishan City, the population in the water supply project areas was predicted to grow by 7% per year because of the expansion of on-site jobs by new energy industries, the domestic automobile industry, and the coal industry. However, unlike the prediction, the population started declining from 2010 owing to reasons such as the withdrawal of local big companies and the relocation of residents, and remained on almost the same level, 730,000 people, with sluggish demand for water; the water demand is 400,000 m^3/day for the supply capacity of 370,000 m^3/day, and the supply and demand are roughly in balance. The demand for sewerage systems is 163,000 m^3/day for the treatment capacity of 80,000 m^3/day, which still needs to be strengthened.

As described above, urban development has continued in Yinchuan City, and the associated demand for infrastructure of water and sewerage is still high. For Shizuishan City, water and sewerage facilities are needed as a whole, but the urban development is stagnant, and the demand has not increased to the extent expected at the time of the appraisal.

3.1.3 Consistency with the Japan's ODA Policy

The *Medium-Term Strategy for Overseas Economic Cooperation Operations (2004–first half of 2007)* by the Japan International Cooperation Agency (hereinafter referred to as JICA), among its priority areas such as support for poverty reduction, infrastructure development toward sustainable growth, and support for global problem solution and peace building, focuses on rural development through improvement of water supply and sewerage systems in poor regions, promotion of sustainable growth through the development of highly needed economic and social infrastructure such as water, sewerage and energy facilities, and the implementation of measures against the pollution of supply water while ensuring that development is compatible with environmental protection.

In addition, the *Country Assistance Strategy* by JICA recognizes environmental problems due to rapid economic growth as a challenge and selected environmental conservation primarily in inland areas as a priority area.

This project is highly consistent with Japan's ODA policy because it is meant to develop water supply and sewerage systems, which make up the environmental infrastructure that is required along with the urban and industrial development of Yinchuan City and Shizuishan City in the

Ningxia Hui Autonomous Region located in an inland area, and thereby to improve the water quality of rivers and the living environment of residents.

3.1.4 Appropriateness of the Project Plan and Approach

(1) Changes in the project scope and working situation in Shizuishan City

Regarding the sewerage project for Shizuishan City, the scale of the operation was reduced by half[5] from the original plan, and the developed sewerage plant was not put into full operation and continued to be suspended until the time of the ex-post evaluation (2019). This is because the situation of the city changed greatly from the time of the appraisal, and the demand itself decreased significantly. More specifically, the coal industry, which was the key industry of the city, went into a sharp decline under the national policies, and coal-related companies, which had been high-volume consumers, withdrew from the city, resulting in a population decline. Since then and up to the present, no alternative industry has developed. For this present situation, whether there were problems with the planning at the time of the appraisal is examined next mainly from two perspectives: 1) the predictability of urban development plans, and 2) the demand review process in the detailed design phase.

1) Predictability of urban development plan of Shizuishan City's population.

At the time of the appraisal, the population of the water supply project areas in urban areas in Shizuishan City was predicted to increase from 280,000 in 2005 to 380,000 in 2010, assuming a growth rate of 7% per year according to the *11th Five-Year Plan for Shizuishan City*. However, the predicted growth was not actually seen, and the population of the water supply project areas in 2010 remained at 330,000. The growth rate of 7% is higher compared to the population growth rate (2.7%: average of 2006 to 2010)[6] of the urban areas in Ningxia Hui Autonomous Region, indicating that the prediction may have been too high.

The biggest factor contributing to the stagnant population growth is the withdrawal of coal-related companies, the signs of which appeared in about 2008; then, the situation worsened further with the world financial crisis in 2009. After 2015, the production adjustment in the coal industry and related processing industries led to further decreases in production output, by which, combined with environmental protection regulations and development of eco-friendly fuels, many local companies were forced to close down. By 2016, 100,000 employees and their family members of Shenhua Ningxia Coal Group Co., Ltd., which was one of the biggest local companies, moved to areas outside the Ningxia Autonomous Region, resulting in a large decrease in population. According to the executing agency, the decrease in population of the city due to the

[5] At the time of the appraisal, the new construction of a sewerage plant with a treatment capacity of 40,000 m^3/day was planned, but in the detailed design stage in 2010, the demand forecast was revised downward, and the treatment capacity was changed to 20,000 m^3/day, half the originally planned capacity.

[6] China Statistics Yearbook 2015

decline of the coal industry amounts to 200,000, including the relocation of other coal-related industries.[7]

2) Appropriateness of demand review in the detailed design phase

In response to the environmental changes mentioned above, in 2010, the executing agency scaled down the project scope. As a result, the plan for construction of the 3rd Sewerage Plant was changed so that the construction would be implemented in two periods by halving the initially planned capacity of 40,000 m^3/day. By the ODA loan project, ancillary facilities were constructed on the same scale as planned initially, and a treatment facility for one period with a capacity of 20,000 m^3/day was constructed.

In the consultation at the time of the ex-post evaluation with the Municipal Development and Reform Commission and the executing agency, they were not able to predict the severe population decrease as mentioned above even at this stage, and responded that they assumed the possibility that there was a certain level of demand. The city government has also worked on the adjustment of industrial structure, attraction of enterprises, preferential agricultural land policies, and plans for immigration from other provinces in order to address the decline of the key industry; however, as yet, there has been no significant change in the population and situation of the city.[8]

Regarding these changes, the evaluator checked with those who[9] involved how at the time of the appraisal,the city government was able to ascertain the trends in the policies of the central government and the structural adjustment for the coal industry and whether there was any defect in that process. Here is an overview:

1. Amid a boom of economic development at the time, there were optimistic predictions on the economic growth of the city, the awareness of environmental regulations was still low, and there was the "economy-first" sentiment. This situation was reflected in the predictions on attraction of enterprises to the industrial development zone and how many of them would move in; this then may have led to too high a prediction.
2. For the water demand, there were guideline values specified by the central government. These values were adopted without taking into account the actual needs.
3. Regarding the withdrawal of coal-related industries, which is the biggest factor contributing to the population decline, there was then already a trend to strengthen environmental

[7] This relocation plan was incorporated into the *12th Five-Year Plan for Shizuishan City (2010–2015)*, and the details were not determined at the time of the appraisal.

[8] At the time of appraisal, about 200 companies were located in the corresponding industrial development zone, but there are currently 170 companies, many of which are said to be small and medium-sized companies. Only less than two-thirds of the available sites in the development zone were occupied, and plants not in operation were often left as they were.

[9] The evaluator interviewed city government officials who participated in the preliminary survey at the time for this project. They were then in charge of collection of data related to the urban development plan and coordination with the design sector.

regulations, but it was not predicted that the regulations would be strengthened this radically and rapidly. To the best of their memory, rumors about company relocation began to be heard from around 2011.

4. Regarding changes in the project scope, a consultation was conducted with JICA after determination of the directions for changes. As for the process that led to the determination, they do not remember having consulted with JICA.

It was about 10 years ago, so it is not certain how accurate their memories are; but there is a high possibility that the predictions on the development of the industrial development zone and the demand for water were not verified strictly. The trends and other changes in the coal industry due to the shift in energy policies were recognized on a medium- to long-term perspective, but for the rapid strengthening of regulations, it cannot be said that there was a predictability at the time of appraisal. To summarize, failure to predict the stagnation of the urban development of Shizuishan City was unavoidable, whereas with regard to project management, the process of review and consensus building on the project plan along with environmental changes had problems with understanding the situation in a timely manner, consultation and coordination with JICA, the accuracy of design, etc.

(2) Appropriateness of feasibility evaluation of reclaimed water supply

Regarding the reclamation facilities implemented in this project, the usage in both cities was far less than the plan (to be detailed in Section 3.3 Effectiveness). With the sluggish growth of demand for clean water, under the circumstance that the lack of water resources had not yet been actualized, the additional investment that user have to bear for the installation of reclamation facilities seems to be a factor that prevented the widespread use of reclaimed water. It is not clear how this factor was evaluated at the time of the appraisal.

Consultation with the agency that conducted a field study revealed that the prevailing view was that the large initial investment for branch sewers, water supply systems, and other equipment required for introduction of reclamation facilities and the high cost to be borne by users prevented the widespread use of reclaimed water. It is acknowledged that, in each treatment plant, negotiations with users are still making slow progress.

The use of reclaimed water is limited to such purposes as water sprinkling and cooling water for plants. Thus, the demand is likely to vary depending on the economic situation. Especially in Shizuishan City, the coal industry, which had been a key industry thus far, moved outside the city; then, industries with a small amount of water usage were invited, and the reclaimed water demand itself decreased significantly. As was described above, these rapid changes took place after the start of the project, therefore it was difficult to predict at planning stage. As a consequence of this, the verification of the feasibility of reclamation facilities might have been left inadequate.

The government still maintains its policy of promoting the use of reclaimed water from the perspective of efficient use of water resources. As a policy measure for that purpose, the government has adopted the *Reclaimed Water Pipe Network Construction and Ordinances for 2016 to 2030*, by which it is mandatory to install reclaimed water pipes in the case of construction of an office building and a housing complex with more than a certain size building area. Through the implementation of these measures, the demand is expected to increase to a certain degree.

Judging from the above, the implementation of this project has problems with the appropriateness of the project planning and approaches, but as a whole, it 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 plans and actual results of the outputs of this project are as shown in Table 1. In Yinchuan City, one water purification plant and one sewerage plant were excluded from the scope of the ODA loan project, while in Shizuishan City, the construction of a water intake facility was cancelled, and the scale of reclamation and sewerage facilities was reduced; in both cities, the construction was scaled down from the plan at the time of the appraisal. In the case of Yinchuan City, many of the facilities that had been initially planned to be constructed by ODA loan project were constructed by domestic funds, and the outputs required to achieve the purpose of this project were actually provided.

Table 1　Plans and Actual Results of the Outputs of This Project

(1) Yinchuan City

	Plans	Actual results
Development of water supply facilities	Water purification plants: Extension of 5th Purification Plant (40,000 m^3/day) New construction of 7th Purification Plant (50,000 m^3/day) New construction of 8th Purification Plant (50,000 m^3/day)	**Some changes made** **As planned** **Cancelled** **As planned**
	Preparation of raw water transmission lines: 121 km	**As planned**
	Construction of wells in 72 places in total 5th Purification Plant: 20 places in total (7,300,000 m^3/year) 7th Purification Plant: 28 places in total (9,130,000 m^3/year) 8th Purification Plant: 24 places in total (9,130,000 m^3/year)	**Changes made** 42 places in total (30 places fewer) **18 places in total (2 places fewer)** **Cancelled** **As planned (24 places)**
Development of sewerage facilities	Sewerage treatment plants New construction of 5th Sewerage Plant (50,000 m^3/day) New construction of 6th Sewerage Plant (50,000 m^3/day) Preparation of distribution pipes Combined sewer system: 147 km Pumping station renovation (1 place)	**Changes made (cancelled partially)** **As planned** **Cancelled** **Changes made** **Preparation of distribution pipes 10 km** **As planned**
Development of reclamation facilities	New construction of a reclamation facility for 3rd Sewerage Plant (30,000 m^3/day) Preparation of reclaimed water pipes: 15 km	**As planned** **Almost as planned 14.8km**

(2) Shizuishan City

	Plans	Actual results
Development of water supply facilities	Water purification plants: Extension of Huinong Purification Plant (80,000 m^3/day) New construction of water intake station in Huinong (180,000 m^3/day) Preparation of raw water transmission lines (53 km)	**As planned** **Cancelled** **Some changes (scale down) 18.2 km (-34.8 km)**
Development of sewerage facilities	New construction of 3rd Sewerage Plant (40,000 m^3/day) Preparation of distribution pipes: Separate sewer system (76 km)	**Some changes (scale down)** Scaled down to 20,000 m^3/day. **Some changes (scale down)** 31.4 km (-45.6 km)
Development of reclamation facilities	New construction of a reclamation facility for 2nd Sewerage Plant (30,000 m^3/day) New construction of a reclamation facility for 3rd Sewerage Plant (20,000 m^3/day) Preparation of reclaimed water pipes (38 km)	**As planned** **Some changes (scale down)** **Altered to 10,000 m^3/day.** **Some changes (scale down) 10.4 km (-27.6 km)**
Training	Manager training and training regarding water reclamation technology in Japan, intended for staff members of executing agency.	**Almost as planned** With seven participants, manager training and training regarding water-saving technology were conducted in Japan in 2008.

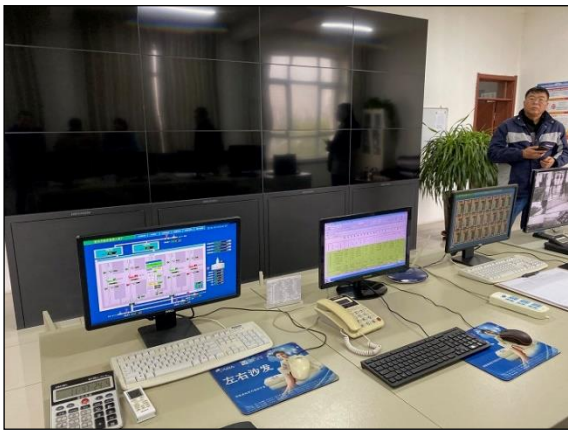
Source: The plans are based on materials provided by JICA; the actual results are based on answers to questionnaires by the executing agency.

The details and reasons of changes are as follows:

(1) Water supply facilities in Yinchuan City

1) Construction of the 7th Purification Plant that had been planned to be built by ODA loan project was cancelled. This was because a water purification plant was built earlier in the neighborhood by domestic funds. In 2012, the Helanshan Purification Plant that uses water from Yellow Riverwas built by domestic funds near the planned construction site for the 7th Purification Plant. Yinchuan City had used groundwater as an intake source, but to prevent depletion of groundwater sources and subsidence of land, a water supply facility that employs surface water was determined to be constructed for groundwater conservation in the city planning of Yinchuan City in 2010. It was then decided that this water supply facility would supply water to the planned water service area of the 7th Purification Plant, the construction of which was then cancelled. This also reduced the scope of the construction of wells, and the construction of 28 sites that had been planned to be developed in connection with the 7th Purification Plant was cancelled.

5th Purification Plant (Pumping Station)



5th Purification Plant (Control Room)

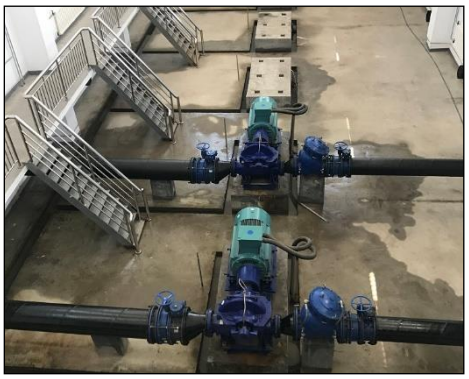
(2) Sewerage facilities in Yinchuan City

The 6th Sewerage Plant that had been planned to be constructed in this project was built by domestic funds. The reason for this change was the urgency of construction. Amid the growing demand for sewerage systems, it took much time to go through each approval process for an ODA loan project. Because of this, the plan was changed in March 2009 to use domestic funds that allow construction work to start in a short period of time. In addition, the total length of water pipes was greatly reduced from the planned 147 km to 10 km. This was also due to the shift to domestic fund-based construction because of the urgency of construction.

(3) Water supply facilities in Shizuishan City

The construction of Huinong District Water Intake Station was cancelled; instead, an intake pump station was built in the center of the Yellow River by domestic funds. The Huinong District Water Intake Station was originally planned to be constructed as an ancillary facility to the Huinong District Purification Plant, but the main consumer was a nearby thermal power station. Because the Yellow River Central Intake Pump Station was constructed for this power station, it was determined that it became possible to satisfy the demand in Huinong District with the existing water intake facilities. The total length of raw water transmission lines was also reduced greatly because some of the pipes were built earlier by domestic funds, in addition to the cancellation of the construction of a water intake station.

Huinong Purification Plant Prepared built under This Project

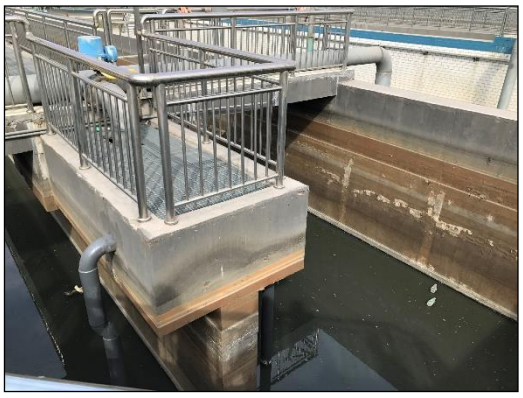


Water Pump System Prepared built under This Project

(4) Sewerage facilities in Shizuishan City

1) In the high-technology district in which economic development with coal had been expected at the detailed design stage, the demand was revised downward owing to population decline, and then the treatment capacity was changed to 20,000 m^3/day, half the originally planned capacity. In addition, the constructed treatment plant has been virtually non-operational since its completion.

2) Regarding distribution pipes, the construction by this project accounted for only 40% of the originally planned work because of prior construction by domestic funds and cancellation of some sections due to decrease in demand. More specifically, 12 km of about 27.2-km sections to be built for the 3rd Sewerage Plant was developed domestically. In addition, the length of distribution pipes of the 2nd Sewerage Plant was greatly reduced to 15.4 km. This was because the coal plants of Ningxia Coal Group moved outside the province and was followed by relocation of residents living in housing complexes, as described above.



3rd Sewerage Plant Not in Operation

Plant Left Unattended in an Industrial Development District (Shizuishan City)

(5) Reclamation facilities in Shizuishan City

The construction of reclaimed water pipes was scaled down from the planned 38 km to 10.4 km because, in planned sites, no tenants had been expected to be present.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost of this project in the planning stage was 18.247 billion yen, of which 8.432 billion yen was to be covered by ODA loan. Of the project outputs, large facilities such as part of a sewerage plant and pipes were constructed by domestic funds, as described above. It was not possible to ascertain how those changes affected the project cost, especially how much in the cost China actually bore. For this reason, here the plan and actual result of the amount of ODA loan project to execute are compared and evaluated. The amount of expenses to be covered by ODA loan project was initially expected to reach 8.432 billion yen, whereas the actual result was 8.368 billion yen, the ratio of which to the plan was 99%, which was lower than planned. However, considering that the total length of pipes of water supply and sewerage systems was shortened and that the construction of wastewater treatment plants was partially covered by domestic funds, it is highly likely that the actual project cost exceeded the planned cost.

3.2.2.2 Project Period

The implementation period of this project was planned to be from June 2007 to July 2012 (62 months), but actually it was extended from June 2007 to October 2018 (136 months), which was significantly longer than planned (220% compared to the plan). The implementation period of each facility is as shown below. The delay in the construction of water supply and sewerage systems in Shizuishan City is especially remarkable. The primary reason was that it took time to make adjustments in the planning stage such as basic design and land expropriation.

Table 2 Implementation Period per Scope

	Target (month)		Actual (Month)		Gap
Yinchuan City Water Supply	2007.6-2012.7	60	2007.6-2014.9	88	147%
	5th Water supply	60	2007.6-2010.1	28	47%
	8thS Water Supply	60	2007.6-2014.5	84	140%
Sewerage	2007.6-2012.7	60	2007.6-2014.9	87	145%
Sewerage & Water Reclamation	2007.6-2012.7	60	2007.6-2009.11	29	48%
Shizuishan City Water Supply	2007.6-2012.7	60	2007.6-2018.10.	136	227%
	2007.6-2012.7	60	2007.6-2018.6	132	220%
Sewerage	2007.6-2012.7	60	2007.6-2018.10	136	227%
Sewerage & Water Reclamation	2th Sewerage & Water Reclamation	60	2007.6-2016.6	107	178%
	3rd Sewerage & Water Reclamation		2007.6-2016.6	71	118%

Note: The month and year of completion of the acceptance inspection, which means the completion of the project, was unknown. Thus, the time of completion was set to the year 2015 so as to suit the Minutes of Discussions (2007).

Table 3 Causes of Delay

Project	Causes of Delay
Yinchuan City Water Supply	It took time to complete the procedure for expropriation of land near residential districts because the study to verify the impact on water resources by the excavation work took longer than planned, and the start of construction was delayed.
Yinchuan City Sewerage	The construction costs per procurement package increased owing to exchange rate variation at the time of acceptance of bid. Because of adjustment of the budget, the design details needed to be revised multiple times, and the start of construction was delayed.
Shizuishan City Water Supply	The restrictions on the intake of water from the Yellow River became more stringent because of water resource management, and it took time to receive permission from the irrigation committee to draw water.
Shizuishan City Sewerage & Water Reclamation	Because the population that requires sewerage treatment was predicted to decrease owing to the downsizing of the coal business mentioned above, a need arose to revalidate the project plan, and it took time to revise and redesign it.

3.2.3 Results of Calculations for Internal Rate of Return (Reference Only)

At the time of appraisal, FIRR were calculated under the following assumptions, such as 30 years of project life, revenue fee as benefit, capital cost, operation and maintenance cost as cost. The results are as follows.

	Appraisal	Ex-post evaluation
Yinchuan City		
Water supply	14.7%	7.13%
Sewage	5.8%	3.38%
Reclamation	12.8%	Negative

FIRR of the project of Yunchun City, both water supply and sewage, declined from that at the time of appraisal. FIRR of water supply declined to 7.13%, as it was calculated based on the net revenue of treatment facilities. However, the actual financial is presumably stable since the executing agency has made TOT-based contract with the city government. FIRR of sewage project was 3.38%, declined from that in the appraisal as well. It was presumably caused by the decline of unite rate of sewage fee from the expected rate. However, it is fair to conclude that the project reaches the certain financial soundness as public-utility industry.

As for Shizuishan City, the evaluator was not able to conduct recalculation due to the lack of adequate data. However, as to be mentioned in 3.3 Effectiveness below, FIRR are highly likely to turn negative on all segment by the factor such as the suspension of sewage facility, decline of water supply and reclamation below the half of planned quantity.

Judging from the above, although the project cost corresponding to the ODA loan project was within the plan, the project period significantly exceeded the plan. Therefore, the efficiency of the project is fair.

3.3 Effectiveness (Rating: ②[10])

3.3.1 Quantitative Effects (Operation and Effect Indicators)

This section is to check the achievements of the target of this project, or achievements of "safe and stable water supply and reduction of water pollutant discharge" in Yinchuan City and Shizuishan City at the time of the ex-post evaluation.[11] Specifically, the indicators set in the planning stage were used to evaluate quantitative effects such as the amounts of water supply,

[10] Sub-rating for Effectiveness is to be put with consideration of Impacts.

[11] The target values and actual values of two years after project completion are compared. For Yinchuan City, data of the water supply and sewerage treatment projects were taken in 2016, two years after 2014, when the project was completed. Data for the reclamation project were taken in 2011, two years after 2009, when the project was completed. In Shizuishan City, since the project was completed in 2018, the same year as that of this evaluation survey, data of the year of project completion were used.

treated sewage, and reclaimed water use in Yinchuan City and Shizuishan City, and qualitative aspects such as the effect of water quality improvement.

(1) Yinchuan City

The operating conditions of the water supply facilities, sewerage treatment facilities and reclamation facilities constructed in this project are described below. As the population of the City is growing, demand on these facilities is increasing. Except for the reclamation facilities, the target for water supply and sewerage treatment has almost been achieved as planned.

1) Water supply project

Indicator	Baseline	Target	Actual		
	2005	2014	2016	2017	2018
	Year of Planning	2 Years after Completion	2 Years after Completion		
Water-Supply Pervasion (%)	90.6	91.1	96	96	96
Water-Supplied Population (ten thousand)	71.6	101.2	140	143	145
Average Water Supply per Day (ten thousand m^3/day)	20	34	31.36	34.88	38.98
Added by This Project		9	7.88	8.05	8.33
Maximum Water Supply per Day		(Designed	45.57	47.15	47.13
Added by This Project		Value)	12.87	12.78	12.46
Water Quality Criteria					
PH		6-9			7.53
Chlorine Compounds		≤250			5
Copper		≤1.0			<0.01
Zinc		≤1.0			<0.05

Source: The plans are based on materials provided by JICA; the actual results are based on answers to questionnaires by the executing agency.
Note: Water-Supply Pervasion = Water-supplied population/Population in the water-supplied area

The water-supplied population of Yinchuan City in 2018 was 1,450,000, showing a significant increase from 720,000 at the time of the appraisal. The target value for two years after completion was 1,010,000, whereas the actual value for the same year was 1,400,000 (139% compared to the plan). The target value for average water supply per day was 340,000 m^3/day, whereas the actual value was 313,600 m^3/day (92% compared to the plan). These data show that the targets have been almost achieved.

As for two water purification plants developed under this project, the average water supply from the 5th Purification Plant (design capacity: 50,000 m^3/day[12]) was 480,000 m^3/day, and that from the 8th Purification Plant (design capacity: 50,000 m^3/day) was 30,800 in 2014, the facility operation rates being 96% and 62%, respectively. The target value for the overall water supply pervasion in the City was 91.1%, whereas the actual value was 96% (105% compared to the plan).

[12] The capacity of the existing facilities (10,000 m^3/day) and that of the newly built facilities (40,000 m^3/day) were added to have this design capacity.

Because the water quality criteria are satisfied, it is fair to say that safe water is supplied in a stable manner.

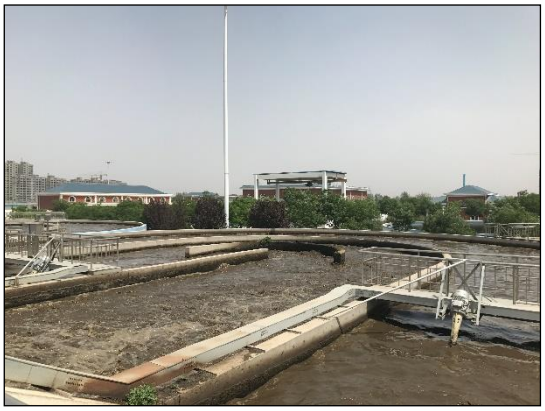
2) Sewerage treatment project

Name of Indicator	Baseline	Target	Actual		
	2005	2014	2016	2017	2018
	Year of Planning	2 Years after Completion	2 Years after Completion		
Population Accessible to Sewerage Treatment Facilities (ten thousand)	57.7	93.1	125.1	126.6	141.3
Volume of Treated Sewage (ten thousand m^3/day)	13.2	32.1	41.7	42.2	47.1
Added by This Project		5 (Designed Value)	4.46	4.37	8.32*
Sewerage System Coverage (%)	56[Note]	87	95.2	95.3	95.5
Pollutants					
BOD Concentration					
Quality of Influent (mg/l)			154	140	119
Quality of Discharged Water (mg/l)	180~200	30	13.3	9.3	3.7
Reduction Rate (%)			91.4%	93.4%	96.9%
COD Concentration					
Quality of Influent (mg/l)	350	100	688	862	665
Quality of Discharged Water (mg/l)			41	30	22
Reduction Rate (mg/l)			94%	97%	97%
SS Concentration					
Quality of Influent (mg/l)	10		40.48	40.23	36.06
Quality of Discharged Water (mg/l)			3.41	2.23	0.31
Reduction Rate (%)			92%	94%	99%

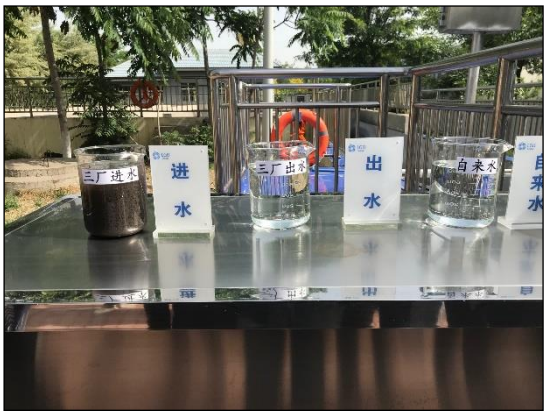
Note: Although technical examinations showed that it was 0, it was corrected to be 56 in MD. This was verified by the executing agency.
Sewerage System Coverage = Sewerage Treatment Capacity/Volume of Sewage

The population accessible to sewerage treatment facilities in the whole of Yinchuan City was 577,000 at the time of the appraisal and significantly increased to 1,251,000 (135% compared to the plan) two years after completion, and further increased to 1,410,000 by 2018. The volume of treated sewage was 132,000 m^3/day at the time of the appraisal and increased to 417,000 m^3/day. It was much larger than the target value of 321,000 m^3/day (130% compared to the plan). The average volume of treated sewage per day of the 5th Sewerage Plant (design capacity: 50,000 m^3/day), which was constructed in this project, was 44,600 m^3/day. The facility operation rate was as high as 90%, showing that it was operating in good conditions. The sewerage system coverage was 95.2%, which was higher than the target value of 87% (109% compared to the plan).

The volumes of pollutants reduced also proved that the effect of treatment was quite high. The reduction rates were higher than 90% both for the biochemical oxygen demand (BOD) and the chemical oxygen demand (COD). To cope with severer environmental policies and discharge criteria determined later, additional improvement work was carried out in 2015. The water quality had been significantly improved by 2018 and reached 1st Class A, the highest quality level specified by the country.



5th Sewerage Plant Constructed under This Project



Comparison of the Water Quality Levels before and after Treatment

1. Reclamation project

Name of Indicator	Baseline	Target	Actual		
	2005	2014	2016	2017	2018
	Year of Planning	2 Years after Completion	2 Years after Completion		
Volume of Reclaimed Water Supply (ten thousand m^3/day)	0.2	5.2	2.726	3.3149	7.2149
Added by This Project		3 (Designed Value)	1.05	1.07	1.3
Proportion in Relation to the Volume of Treated Water (%)	1.4	16.2	6.22	7.48	14.63

Note: Proportion in relation to the volume of water treated in the reclamation facilities = consumption of reclaimed water/volume of treated sewage
The baseline values include those for the existing facilities in Yinchuan City (six water supply facilities, three sewerage treatment facilities and one reclamation facility)

Although the need of plants and public facilities for reclaimed water in 2020 was estimated to be 240,000 m^3/day at the time of the appraisal, the water supply to businesses (main users) is not increasing as expected. This is because many users do not want to share the cost of installing reclaimed water pipes and because awareness on reclaimed water has not been sufficiently raised among businesses. Although the supply of reclaimed water increased by 2018 from 2,000 m^3/day at the time of the appraisal to 72,000 m^3/day in 2018 at the time of the ex-post evaluation, it remained low when compared with the value of demand expected at the time of appraisal.[13] Although the design capacity of the reclamation facility in the 3rd Sewerage Plant constructed in this project was 30,000 m^3/day, the actual volume of supply was 13,000 m^3/day as of 2018, and the facility operation rate had been lower than half the design capacity since the time of the start

[13] Many of the present sewerage treatment plants have upgraded their treatment processes to cope with restrictions that are getting severer, and the water quality after treatment is high enough to be used as reclaimed water. They say that the existing sewerage treatment plants have enough capacity to supply reclaimed water sufficiently if the demand would increase and the pipe network was fully developed.

of operation. Main users of reclaimed water were limited to thermal power plants and tree-planting businesses in economic development areas.

The executing agency says that ordinance were introduced to facilitate water saving, in which it is required to install reclaimed water pipes whenever a plant or housing complex with a certain area size is constructed. Therefore, the network of reclaimed water pipes may be developed, and the demand for reclaimed water may increase to a certain extent. At present, however, it is not possible to have a clear view of future increases in demand, because demand for plant construction is not growing and because the effectiveness of the regulations has not been fully proven.

To facilitate the use of reclaimed water, additional investment is needed for developing the network of reclaimed water pipes. At present, use of reclaimed water is limited, and it would be difficult to expand the demand for such water. In the discussion with the experts who accompanied the evaluator, it was pointed out that the demand for reclaimed water would not significantly expand for the time being, and that reclaimed water could possibly be supplied to water supply systems if measures are taken such as additional installation of desalination apparatus.[14]

(3) Shizuishan City

The operating condition of the water supply facilities, sewerage treatment facilities and reclamation facilities developed by this project are described below. Unlike the situation of Yinchuan City, the population of Shizuishan City has not significantly increased, and the amounts treated both in the water supply facilities and sewerage treatment facilities were much less than those expected at the time of appraisal.

[14] To improve the quality of reclaimed water so that it can be used as clean water, desalination apparatus should be installed to remove soluble salt that remains in reclaimed water. Such apparatus can separate soluble salt from water. In treating reclaimed water whose salt concentration is quite low, the apparatus is expected to use significantly less energy than in treating other types of water. Therefore, use of reclaimed water in the water supply system could be feasible if the construction cost of the apparatus is kept low.

1) Water supply project

Indicator	Baseline	Target	Actual	
	2005	2014	2017	2018
	Year of Planning	2 Years after Completion		Year of Completion
Water-Supply Pervasion (%)	45.0	83.0	94	94
Water-Supplied Population (ten thousand)	12.5	34.4	41	41
Average Water Supply per Day (ten thousand m^3/day)	9	17.6	13.86	13.67
Added by This Project (ten thousand m^3/day)		8 (Designed Value)	3.39	3.35

As of 2018, there were four water purification plants in Shizuishan City, the total supply capacity being 190,000 m^3/day. The water supply capacity of Huinong Purification Plant, which had been developed in this project, was the maximum at 120,000 m^3/day (40,000 m^3/day by existing facilities and 80,000 m^3/day by newly added facilities). Although the total amount of water supply for the City was 90,000 m^3/day at the time of the appraisal, it had increased to 136,700 m^3/day by 2018 (78% compared to the plan). The water-supplied population had also increased from 125,000 to 410,000 in the same period (120% compared to the plan). The amount of water supply from Huinong Purification Plant, which had been developed in this project, was almost unchanged (fluctuating in the range of 32,000 to 48,000 m^3/day) over the past ten years. In the year of project completion, it was 33,500 m^3/day. The facility operation rate had been in the range of 30 to 40%. The major reason for the stagnant operation rate is that, as mentioned in the section of Relevance, the total population in Shizuishan City had been almost unchanged. Huinong, which used to receive many businesses at one time, has seen its population decrease, and demand for service water has not increased much. Although the Government of Shizuishan City is trying to invite businesses from various industries to promote urban development, it has not succeeded to attract big enterprises, which could play a central role in establishing a basic industrial sector in the City. As there is no evidence that the situation will improve in a short period of time, it should be expected that the operation rate of water supply facilities will stay low. The quality of treated water is high enough to meet the national standards.

2) Sewerage treatment project

Indicator	Baseline	Target	Actual	
	2005	2014	2017	2018
	Year of Planning	2 Years after Completion		Year of Project Completion
Population Accessible to Sewerage Treatment Facilities (ten thousand)	12.5	34.4	41	41
Volume of Treated Sewage (ten thousand m^3/day)	2.7	17.1	7.21	7.51
Added by This Project		2 (Designed Value)*	Operation Stopped	Operation Stopped
Sewerage System Coverage (%)	62	38	96%	94%
Quality of Discharged Water (BOD Concentration) (mg/l)	200	30	N/A	N/A
Quality of Discharged Water (COD Concentration) (mg/l)	400	100	N/A	N/A

As of 2018, Shizuishan City had four sewerage treatment plants, the total treatment capacity being 127,600 m^3/day. The total volume of treated sewage in the City increased from 27,000 m^3/day at the time of the appraisal to 75,100 m^3/day in 2018 (44% compared to the plan). The population accessible to sewerage treatment facilities increased from 125,000 to 410,000 (120 % compared to the plan). The sewerage system coverage was also improved from 62% to 94% (247% compared to the plan). The 3rd Sewerage Plant (20,000 m^3/day) was newly built in this project, and it was completed in October 2012. Since the completion of construction, however, the plant has been hardly operated.[15] The reason for this is the same as that described for the water supply project. The population of the targeted area decreased significantly because a coal producer, which had been assumed to be a large-scale demander, moved out of the City and the employees of the company also moved out. The demand for sewage had not increased as predicted due to the decline of local industry which consume huge amount of water. The Government of the City says that it plans to have new economic development areas to attract businesses, and this sewerage treatment plant could be effectively used to treat sewage produced in these areas.[16] At present, however, it is not clear if they will succeed in this effort. Even if medium-term development of the City is taken into consideration, it is fair to say that the impact of the sewerage treatment project was proved to be low.

3) Reclamation project

Reclamation facilities are installed in the 1st to 3rd Sewerage Plants, and the total production capacity for these Sewerage Plants is 82,600 m^3/day. The total production capacity in the City is

[15] A test operation of the plant was conducted in June 2013. It operated for four months in 2014 and only produced a small amount of reclaimed water.

[16] It is also planned to construct industrial wastewater treatment facilities in sewerage treatment plants to treat sewage produced in the economic development areas. According to the schedule, construction will start in December 2019. However, the amount of sewage treated by these facilities is estimated to be only in the order of several thousand m^3.

80,000 m^3/day, against the planned of 90,000m^3/day (89% compared to the plan) and the total production water in 2018 was 75,100 m^3/day in 2018. However, the supplied reclaimed water was only 9,500 m^3/day, which just accounts for 12.6% of the actual consumption to the production. Although the reclaimed water supply capacity is maintained, the efficiency of the reclamation facilities is considered low from the perspective that reclaimed water is intended to be used in place of clean water.

As of 2018, although the amount of reclaimed water supply from the 2nd Reclamation Facility constructed in the 2nd Sewerage Plant in this project was 32,600 m^3/day, the actual consumption of reclaimed water was only 4,000 m^3/day.[17] The reclaimed water was supplied to a power station nearby to be used as cooling water. Reclaimed water consumption remained at a low level partly because there were not enough demanders in the City. Similar to the case of Yinchuan City, it was also because users were not willing to share the cost of installing reclaimed water pipes. In this project, the 3rd Reclamation Facility was also constructed in the 3rd Sewerage Plant. Because the plant is not operating, the reclamation facility has no record of operation.

Use status of the Reclamation Facility installed in the 2nd Sewerage Plant

Indicator	Baseline	Target	Actual	
	2005	2014	2017	2018
	Year of Planning	2 Years after Completion		Year of Project Completion
Amount of Reclaimed Water Supply (ten thousand m^3/day)	0.2	9.0		3.26
Actual Consumption				0.4
Proportion in Relation to the Volume of Treated Water (%)	6.3	16.2	4	5

As explained above, the benefit of the reclamation project will not grow for the time being. In future, however, demand for reclaimed water may increase. A project for developing a reclaimed water pipe network, which was jointly founded by the government and the executing agency, was approved, and the construction work started in the summer of 2019. When this project is completed, the pipe network will be significantly improved, and reclaimed water will be supplied to about 50 companies. It is planned that reclaimed water may be supplied at the rate of about 30,000 m^3/day in five years, and at the rate of about 60,000 m^3/day in 20 years.

4) Operating conditions throughout the two cities: The table below shows the operating conditions of main facilities in the two cities and comparison between the total target values and actual total values. When comparing the total volumes of water supply for the two cities

[17] Since completion of the sewerage treatment plant in 2012, the actual consumption of reclaimed water has been at a low level, and 11,300 m^3/day was the highest record.

with that of the target values, the average target achievement rates of water supply facilities and sewerage treatment facilities were found to be 60 to 70%, which is a medium level.

	Target			Actual(2018)			Target Achievement Rate
	Total	Yinchuan	Shizuishan	Total	Yinchuan	Shizuishan	
Amount of Clean Water Supply	51.6	34	17.6	13.67	N/A	13.67	N/A
Added by This Project (Design Value)	**17**	**9**	**8**	**11.68**	**8.33**	**3.35**	**69%**
Amount of Treated Water	49.2	32.1	17.1	49.21	41.7	7.51	100%
Added by This Project (Design Value)	**7**	**5**	**2**	**4.32**	**4.32**	**0**	**62%**
Amount of Reclaimed Water Supply	14.2	5.2	9	10.47	7.21	3.26	74%
Added by This Project (Design Value)	**6**	**3**	**3**	**1.7**	**1.3**	**0.4**	**28%**

*Because complete data of the two cities were not available, comparisons between designed capacity and actual operational conditions were made mainly for the facilities that were developed in the project financed by ODA loan project.

Based on data shown above, the effects of this project are evaluated as follows.

1) As the operation level of the facilities in Yinchuan City is much higher than the planned level, effectiveness of the facilities is evaluated as highly satisfactory. Although the achievement level of the reclamation facilities is low, the negative effectiveness is considered small in view of the objective of this project, "safe and stable water supply and reduction of water pollutant discharge." In consideration of the small amount of investment, the overall effects of the facilities in Yinchuan City are evaluated as high.
2) The operational conditions of clean water supply facilities, reclamation facilities and sewerage treatment facilities in Shizuishan City are all at a low level. Because the population is not growing, demand increase cannot be expected, and this situation will probably not change drastically in a short period of time. Consumption of reclaimed water may increase in the future because ordinance on the promotion of reclaimed water use have been established. At present, however, it is not possible to have a clear view regarding the effectiveness of regulations, and progress of the situation must be watched. Consequently, the effectiveness of the facilities in Shizuishan City is evaluated as low at this moment.
3) When compared with Shizuishan City, the benefit of and the amount of water supply for Yinchuan City is larger. If the values of the two cities are combianed, the target achievement rate of water supply facilities and sewerage treatment facilities is found to be 60 to 70%. In consideration of the fact that effectiveness is low in Shizuishan City and high in Yinchuan City, the overall effect could be evaluated as fair.

Consequently, the effectiveness of the project is evaluated as fair.

3.4 Impacts

3.4.1 Intended Impacts

In this project, the impacts are related to the "improvement of living environment for people of Yinchuan City and Shizuishan City." To be precise, the effects of constructing sewerage treatment facilities and water supply facilities were verified in view of 1) water environment improvement, and 2) betterment of residents' convenience and satisfaction, and dwelling environment improvement. Because the quality of river water may be affected not only by development of sewerage treatment facilities but also by many other factors, it is difficult to determine to what extent this project contributed to the improvement of extensive river water quality. As for interview results, as the number of people interviewed is limited, they should be only used as qualitative supplemental data for understanding the results confirmed for effectiveness of the project.

(1) Water environment improvement

1) Data obtained from monitoring at a Yellow River observation spot

The water quality of the Yellow River in Yinchuan City has changed as shown in the table below. The water quality in Yinchuan City has improved from Class III at the time of the appraisal (2005) to Class II, and this means that it can be suitably used as a drinking water source. During this period, the sewerage treatment rate in Yinchuan City improved from 56% to 95%, and the amount of untreated sewage flowing into the Yellow River decreased substantially. Although it is difficult to show a direct causal relationship, it can be assumed that the installation of sewerage treatment facilities had a positive impact of improving the river water quality to a certain degree.

	2004	2005	2016	2017	2018
Classification of River Water Quality	Class IV	Class III	Class II	Class II	Class II
COD (mg/m^3)	17.2	11.7	9.0	9.0	7.8
BOD (mg/m^3)	3.2	3.4	2.0	1.5	0.8
Sewerage Treatment Rate (%)	N/A	56%	95.2%	95.3%	95.5%

Source: Data for 2004 and 2005 are from documents provided by JICA.
Data for 2017 and 2018 are taken from questionnaire responses of Government of Ningxia Hui Autonomous Region
*The observation spot was Ye Sheng Yellow River Bridge in Yinchuan City

As mentioned above, because the sewerage treatment plants in Shizuishan City are not in operation, it is judged that there is no apparent positive impact on water quality.

(2) Betterment of residents' convenience and satisfaction, and dwelling environment improvement as a result of water environment improvement

1) Beneficiary interview results

An interview with residents of Yinchuan City[18] was conducted to ascertain the level of awareness and evaluation of beneficiaries regarding "water environment improvement," and to study the betterment of residents' convenience and satisfaction and dwelling environment improvement by comparison of the situation before the project start (2005) with that at the time of the ex-post evaluation (2019). Some of the interview results obtained are shown below.

1. Improvement of residents' convenience and dwelling environment

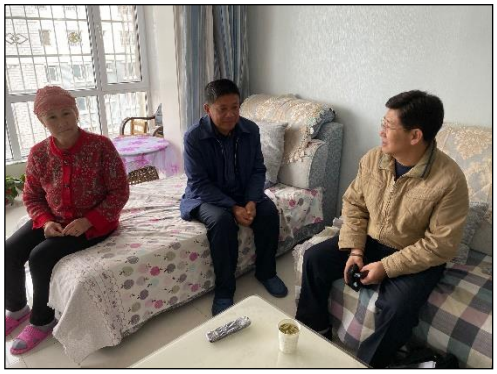
There were several comments that, because of the construction of distribution pipes and the sewerage system, a nasty smell in houses and the environment was removed and the living comfort of residents was improved. An interviewee said, "Before the start of this project, as sewage pipes were thin, sewage pools were formed on the ground. Windows of rooms could not be opened in summer or after rainfall because of the nasty smell. Now the rooms are brighter as we can open windows without worrying about it." Another interviewee answered, "Formerly, distribution pipes were thin, and clogging was caused often. We took a shower only once a week to reduce the production of wastewater. Now we can take a shower whenever we like." Many people said that hygiene in the environment had improved with the installation of drain ditches.

A couple who run a beauty salon in a housing complex said, "Life satisfaction increased because infrastructure such as water supply and sewerage systems had been improved. Although we used to suffer the inconvenience of frequent water supply suspension, we have not experienced any water supply suspension since we moved here."

2. Changes in water environment and river environment

They commented that their health condition had improved and they can enjoy leisure time in the river area. An interviewee said, "As the quality of river water was improved, the nasty smell and muddiness was reduced. The riverbed environment is maintained, and we now enjoy fishing there."

Irrigation Channel near a Sewerage Treatment



Residents Interviewed (Yinchuan City)

[18] A group interview was held in the form of a discussion to hear comments on changes in the water environment and its impacts on the life of residents. Eight interviewees (seven men and one woman) were selected with the cooperation of the executing agency.

Facility Constructed in This Project
(Yinchuan City)

Although the number of the interviewees was limited, several people commented that their dwelling conditions had improved owing to the stable water supply. Therefore, it seems that people's total satisfaction regarding the water supply has increased.

3.4.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

In the environmental impact assessment (hereinafter referred to as EIA) conducted at the time of the appraisal, it was concluded that negative impacts on the natural environment were at the lowest level because this project was carried on in regions far from natural parks or other vulnerable areas.[19] Although ground water is being used as a source of water supply in Yinchuan city, it was concluded that significant effects from construction of well were not expected when the location of aquifers and the amount of target water were taken into consideration. It was confirmed in the project plan that the sludge produced in the sewerage treatment facilities could be adequately disposed of at existing landfills. It was planned that environmental effect mitigation measures would be taken to prevent ground pollution and the production of noise and vibration. Therefore, it was considered that significant concerns were not generated by this project. Because field study proved that unpredicted problems were not caused in actual construction work or during the stage of plant operation, it was concluded that no specific problems had arisen.

(2) Impacts on the Social Environment

At the time of the appraisal, it was informed that they had already obtained the right to use planned construction sites, and there was no need for land acquisition nor resettlement of residents. When the executing agency was interviewed for the ex-post evaluation, they said that it was devastated land and legally acquired without causing any problems, and that resettlement of residents was not needed.

Based on the considerations described above, the effectiveness and impacts of the project are fair. As mentioned in the section for Effectiveness, it was confirmed that water supply facilities and sewerage systems in Yinchuan City were generally operating in good condition, the water quality of the Yellow River in the City indicated an improving trend, and the satisfaction of residents was quite high. In Shizuishan City, however, the operation rates of water supply facilities and sewerage systems are much lower than the target values because the key industry of the City moved out, and urban development and population growth are at a lower level than

[19] According to the *Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations (April 2002)*, it was classified as Category B.

expected in the initial plan. Taking these factors into consideration, the overall project effect in the two cities is evaluated as fair.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional/Organizational Aspect of Operation and Maintenance

The construction was carried out by Yinchuan City Urban Construction Co., Ltd. and Shizuishan Xinghan Municipal Industry Group Co., Ltd., which take charge of public works related to the water environment improvement in the Ningxia Hui Autonomous Region. At the time of the appraisal, it was said that a state-owned company would be responsible for the operation and maintenance of this project on consignment from the City Government. At the time of the ex-post evaluation, however, it was found that the institutional/organizational system of operation and maintenance was changed in Yinchuan City. Sewerage treatment plants are operated and maintained by a joint corporation with a foreign company using the TOT method.[20] The institutional/organizational systems of operation and maintenance in the two cities are described below.

(1) Yinchuan City

1) Water supply project

At the time of the appraisal, it was planned that the water supply project would be operated and maintained by a state-owned company, Yinchuan Water Supply Company. At the time of the ex-post evaluation, however, it was actually managed by Yinchuan Railway Waterworks Group Co., Ltd., which was established in 2011. It is a state-owned self-supporting company, for which the State-owned Assets Supervision and Administration Commission takes a 51% stake, and Railway Corporation takes a 49% stake. The number of employees is 1,000, and 300 of these employees are qualified engineers.

In the initial plan, water purification plants covered by this project were assumed to be operated and maintained by 23 staff members. As work efficiency has increased by appropriately distributing experienced members and introducing an unmanned central control room, the 5th Purification Plant is now operated by 13 staff members, and the 8th Purification Plant by 15 staff members. This means that efficient operation has been realized with the staff size being cut nearly by half. The Government of the Ningxia Hui Autonomous Region and the City Government implement periodic supervision and instruction of the plants. It was proved that the institutional/organizational system of operation and maintenance had no problems.

2) Sewerage Treatment Project

[20] TOT is an abbreviation for Transfer Operation Transfer. It means a patent management right with which plants are constructed in a project financed by ODA loan project, managed (operated and maintained) by a private company and returned to the state of China at the end of a certain contact period. The period for this project is 30 years.

At the time of the appraisal, it was planned that the sewerage treatment project would be operated and maintained by Yinchuan Sewerage Treatment Co., Ltd. It is now managed by Shangye Environmental Co., Ltd. because Yinchuan Sewerage Treatment Co., Ltd. was purchased by this enterprise. Since 2015, this project has been managed adopting a 30-year TOT (Transfer Operation Transfer) method. As shown in the table below, sewerage treatment plants are managed by joint corporations under the supervision of Shangye Environmental Co., Ltd.

Plant Covered by This Project	Name of Managing Company	Outline
3rd Sewerage Plant	Duli Sewerage Treatment Co., Ltd. (joint corporation with Malaysia)	30 staff members of which6 engineers, 1 with professional qualification
5th Sewerage Plant	Shangmi Environment (Yinchuan) Sewerage Treatment Co. (joint corporation with Singapore)	26 staff members of which 1 with professional qualification)
6th Sewerage Plant	Yinchuan Xing Environmental Development Co., Ltd. (state-owned company)	30 staff members of which 1 with professional qualification)

(3) Shizuishan City

The system described in the plan has not been changed, and Shizuishan Xingji Group Sufficient Water Supply-Discharge Co., Ltd., a subsidiary company of Shizuishan Xinghan Municipal Industry Group Co., Ltd. takes charge of operation and maintenance of the water supply plants and sewerage treatment plants. The company has 455 employees (including 273 engineers). The water supply plants and sewerage treatment plants are mainly administered by the company's Administration Department, Finance Department, Safety Control Department and Technical Development Department. Huinong Branch Company (number of employees: 187), a subsidiary company, operates and maintains Yellow River Purification Plant (40 engineers) and the 2nd Sewerage Plant (five engineers). Although Dawu Branch Company, another subsidiary company, was expected to operate and maintain the 3rd Sewerage Plant, it was not operated at the time of the ex-post evaluation, and four staff members were posted there for inspection. As each organization has sufficient experience in the management of water supply and sewerage treatment facilities, no special problems are found concerning the system scale of these organizations.

3.5.2 Technical Aspect of Operation and Maintenance

(1) Yinchuan City

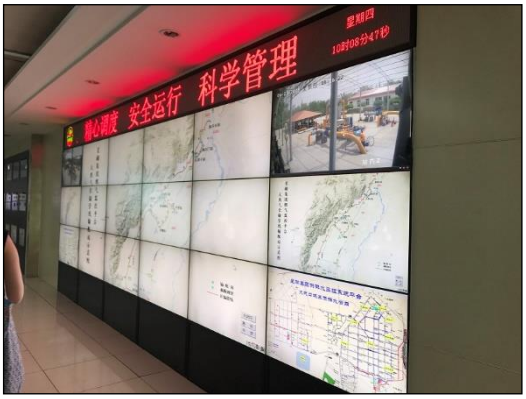
As for water supply and sewerage plants in Yinchuan City, all the managers of the 5th and the 8th Purification Plants are engineers. Although a periodic inspection manual is not provided, no technical problems are seen because they have a satisfactory size of staff that can cover processes related to the design and construction of water supply systems, water supply and distribution, information control, legal work, electrical work, etc. Training courses are provided for staff

members to improve their technical skills. They may be sent to the Chinese Water Supply Association for training or may participate in periodic training offered by the company.

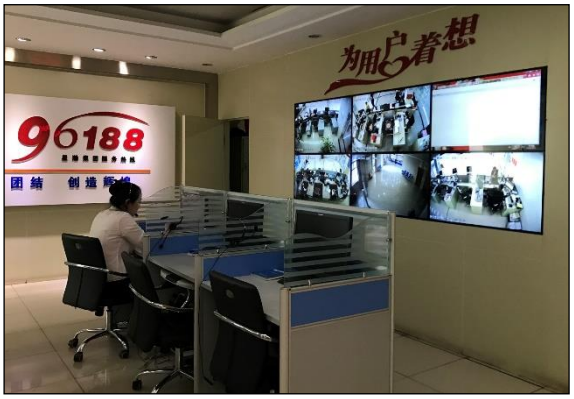
(2) Shizuishan City

As for water supply and sewerage plants in Shizuishan City, Yellow River Purification Plant has 40 engineers, and they receive training 12 times a year to keep and improve their technical skills in operation and maintenance. Regular and periodic inspections are performed appropriately by an associated company. Maintenance and inspection manuals are provided only for reclamation facilities. During the period of field study, facility maintenance logs, inspection records, etc. were used to interview the staff. Because all the staff members answered the questions properly concerning the workflow and responses in the process of which they were in charge, it was confirmed that the skills and knowledge required for operation were maintained and management was performed systematically. In reclamation facilities, cross-checking is also done by asking an external institution to assess water quality and noise quarterly. Water safety is also evaluated by an external third-party organization, and it was accredited to meet safety criteria for 3C.

Based on the considerations described above, it is concluded that both the water supply system and the sewerage treatment system are infrastructure already established in China. Therefore, their technical skills required for operation are evaluated as satisfactory. Each organization allocates specialists to the facilities. Periodic training courses are given to provide expertise and technical knowhow. These efforts show that the technical level of operation and maintenance is satisfactory without causing any particular problems. In 2003, as a first attempt in China, Yinchuan City provided a smart water meter for each family. As the City is located in a dry region, this active attempt is expected to solve the water-shortage problem. Furthermore, it may improve residents' convenience in paying for water charges and improve non-revenue water control.



Central Control Room of the Executing Agency (Shizuishan City)



Central Control Room of the Executing Agency (Shizuishan City)

3.5.3 Financial Aspect of Operation and Maintenance

Pieces of key information such as the financial conditions of the executing agency, particularly profit and loss statement and balance sheet, were not disclosed because they were deemed confidential. Therefore, soundness of the financial conditions had to be analyzed using interview results obtained on site. Because detailed analysis based on financial statements was not performed, the analyses below do not reflect the actual financial conditions in a satisfactory manner.

(1) Yinchuan City

In Yinchuan City, the water supply project has been operated in the form of a public benefit service by a state-owned company without experiencing any significant changes since the time of the appraisal. As for the sewerage treatment plants, each plant is operated on a self-supporting basis by introducing TOT with a private company. A rough estimation on the financial conditions of each organization is shown below.

1) Water supply project

   Yinchuan Railway Waterworks Group Co., Ltd. maintains surplus management and has no profitability problems. The water supply project has been operated in the form of a public benefit service by a state-owned company, and water charges are officially fixed. As a public benefit service company, its performance evaluation is stable at a top-class level. As smart water meters and electric payment have been introduced to pay for water charges, the degree of collection rate has increased. Because introduction of such payment systems is supported financially by the State Government, the company may be able to increase capital investment.

2) Sewerage treatment project

   According to the policy of the Yinchuan City Government, each of the eight sewerage treatment plants in the City entrusts its operation to a private company based on TOT. For example, the 3rd Sewerage Plant, construction of which was financed by an ODA loan, entrusted its operation to Duli Sewerage Treatment Co., Ltd., a joint corporation with Malaysia, under the contract that an administrative cost of 810 million yuan (about 14 billion yen) can be received for 30 years. It was also determined under the contract that an earning rate of 7% is ensured. As an additional contract of 1.2 billion yuan was concluded later, there should not be any significant problems caused in terms of revenue.

(2) Shizuishan City

Shizuishan Xinghan Municipal Industry Group Co., Ltd., the parent company of the executing agency, is a state-owned company established in 2004. Its total capital is 3.8 billion yuan (about 64.6 billion yen), and annual income is 1 to 1.2 billion yuan (about 17 to 20.4 billion yen.) As mentioned above, additional investment in sewerage treatment plants, whose operation is

suspended, is being considered, and it was assumed that its financial soundness has been maintained. Because the water supply project and the sewerage treatment project are both operated in the form of a public benefit service, the business investment relies on government expenditure. Therefore, it is assumed that the financial soundness required to maintain operation will be ensured for the time being, even if the operation rates of water supply and the sewerage treatment facilities are lower than the target values.

State-owned companies are supported by capital investment from the State Government, and the foundation for profits for private companies participating in the project based on TOT is ensured by the contract. Although detailed information is limited, it is assumed that there are no significant problems with regard to the financial conditions of the projects.

3.5.4 Status of Operation and Maintenance

The facilities constructed in the two cities in this project are maintained and inspected periodically, and fundamental soundness has been maintained so far. In Yinchuan City, a 24-hour online control system was introduced, and a stable management system has been established. In Shizuishan City, however, operation of the 3rd Sewerage Plant and the 3rd Reclamation Facility has been suspended since a certain point of time in 2004. Although periodic inspections are being performed, there is a concern that some machines may have deteriorated in the medium and long period of time owing to passage of water through them. There is a great concern that early operation restart of these plants cannot be expected when the lifetime of the facilities is being shortened.

As mentioned above, there is no significant problem in this project concerning the institutional /organizational and technical aspects of operation and maintenance. Although the financial aspects could not be fully verified, both the state-owned companies and the private companies are financially sound owing to the support from one of the City Governments. The current status of the facilities in Yinchuan City is satisfactory and has not caused any problems.

On the other hand, the sewerage treatment facilities and reclamation facilities in Shizuishan City have been mostly unoperated since the time of their construction completion, and it is not expected that this situation will improve in the short term. As the facilities will deteriorate in the medium and long term, and the life expectancy of the facilities left are being shortened, there is a concern in view of the effective sustainability of these facilities.

It is concluded that some minor problems have been observed with regard to the current status. Therefore, the sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented to secure a stable and safe water supply and to reduce the discharge of water pollutants by building water supply and sewerage facilities and reclamation facilities in Yinchuan City and Shizuishan City in the Ningxia Hui Autonomous Region, thereby improving the living environments for residents in both cities.

This project is in line with the policies and needs of the Japanese and Chinese governments and is relevant in general. However, as for Shizuishan City, the project outputs and effects deviated from the project plan along with stagnation of urban development, and there was possibly a problem with the accuracy of the project plan at the time of the appraisal. Regarding the project outputs, facilities were built as planned in general, although changes were made and the period extended because of substitute improvements based on domestic funds. The project cost was lower than planned but the project period was significantly longer than planned; thus, the efficiency of the project was fair.

Regarding the resulting effects of this project, there is a contrast between Yinchuan City and Shizuishan City. Satisfactory results were accomplished in Yinchuan City, whereas the results in Shizuishan City were less satisfactory because the water supply work was not accomplished as planned owing to population decrease in the relevant areas, and the sewerage facilities are barely in operation. Thus, the effectiveness of this project is evaluated as fair. For both cities, there are no problems with the structure of the organization in charge and technical and financial aspects. However, in Shizuishan City, a situation with no chance of using the facilities, especially sewerage and reclamation facilities, has continued, and thus there seems to be some problems with sustainability. Based on the above, this project is evaluated as partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

1) **Need for maintaining reclamation facilities and sewerage treatment facilities in Shizuishan City**

Operation of reclamation and sewerage treatment facilities in Shizuishan City has been suspended owing to a reduction in needs caused by the population decrease. At present, water is partially passed, and periodic inspections are conducted by the executing agency. As a rapid increase in needs cannot be expected, it is desirable to reexamine how to maintain the facilities. For example, machinery could be uninstalled and stored separately to prevent deterioration in anticipation of operation restart.

2) **Further use of reclamation facilities**

Reclamation facilities are also not fully used in Yinchuan City. This is because the use of reclaimed water is limited owing to its quality and because capital investment is needed to develop a network of reclaimed water pipes. Use of reclaimed water may be facilitated by improving reclaimed water quality. For example, reclaimed water could possibly be supplied to water supply systems if a desalination apparatus is installed to remove salt.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Timely scope change and response required by significant change of external environment

Although population growth is essential to increase the needs for supply water and sewerage treatment, it was depressed in Shizuishan City, leading to low effectiveness of the project. The main reason for this is change in the industrial structure, which was uncontrollable as it was caused by the country's policy. It may have been possible to reduce the impacts, however, if the trend had been well examined and discussions had been held with those concerned at an early stage to reduce risks. In this project, communication with JICA concerning a review of the project plan was not taken in a timely manner. It is desirable to establish a risk management system in which risk factors interfering with achievement of the project's goal are pointed out, and information sharing and cooperation with those concerned is facilitated on important occasions such as at the time of appraisal and detailed designing.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs 1) Yinchuan City a. Water supply project Water purification plants Water supply pipe Construction of wells b. Sewerage treatment project Sewerage treatment plants Sewerage water pipe Reclamation facility 2) Shizuishan City a. Water supply project b. Sewerage treatment project Sewerage treatment plant Reclamation facility 3) Training	 Two newly built plants, one plant as an extension 121 km 72 in total Two newly built plants 147 km One newly built reclamation facility, pipe length 15 km Water purification plant (extension), water intake station (newly built), pipe development (53km) One newly built sewerage treatment plant, pipe length 76 km Two newly built reclamation facilities, pipe length 38 km Training in Japan on water supply and sewerage treatment projects	 One newly built plant, one plant as an extension As planned 42 in total One newly built plant 10 km As planned Water intake station cancelled, reduction of the total pipe length Reduction in size, total pipe length 31.4 km Size reduction of one facility, total pipe length 10.4 km Almost as planned
2. Project Period	June 2007 – July 2012 (62 months)	June 2007 – October 2018 (136 months) target achievement rate: 220%
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange rate	 9,758 million yen 8,489 million yen 18,247 million yen 8,432 million yen 1 yuan = 14.8 yen (As of December 2006)	 Cannot be calculated Cannot be calculated Cannot be calculated[21] 8,368 million yen 1 yuan = 15.13 yen (Average from 2006 to 2017)
4. Final Disbursement	September 2015	

[21] The total cost of the project outputs could not be calculated because it was difficult to determine how much of a domestic fund was invested in cancelled or scaled-down output, and to what extent it was supported by an ODA loan. Therefore, the project cost of the whole output of this project could not be calculated.