Republic of Peru

FY 2015 Ex-Post Evaluation of Japanese ODA Loan Project
"Provincial Cities Water Supply and Sewerage Improvement and Expansion Project
(Iquitos, Cusco and Sicuani)"

External Evaluator: Hajime Sonoda, Global Group 21 Japan, Inc.

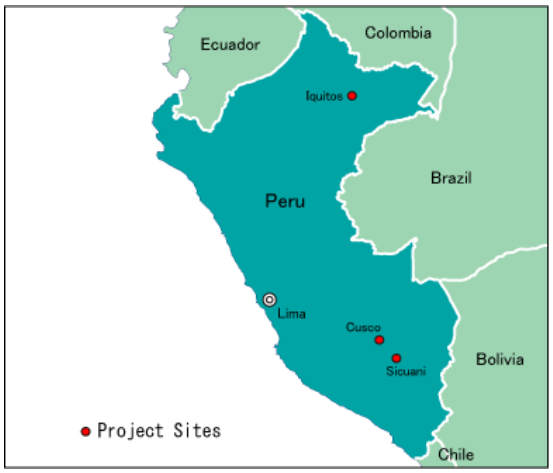
0. Summary

The Provincial Cities Water Supply and Sewerage Improvement and Expansion Project (Iquitos, Cusco and Sicuani) (hereinafter referred to as "the Project") was implemented in order to improve the water supply and sewerage coverage rate in the Peruvian regional cities of Iquitos (Loreto Region), Cusco and Sicuani (Cusco Region) by means of improving and constructing water supply and sewerage facilities as well as enhancing capacity for water production and sewerage treatment, thereby contributing to improvement of environmental and sanitary conditions in the target area. From the time of the ex-ante evaluation through to the ex-post evaluation, the water supply and sewerage sector remained an important issue for the Government of Peru. At the time of the ex-ante evaluation, needs for water supply and sewerage development in the three target cities were high, and the Project facilities are playing an important role at the time of the ex-post evaluation. Moreover, the Project was consistent with Japan's aid policies at the time of the ex-ante evaluation. Therefore, the relevance of the Project is high. Due to two changes of government and deterioration of the operating conditions by Sanitation Service Company (hereinafter referred to as "SSC") in the target cities following signing of the loan agreement, construction works of the sewerage component in Cusco and the water supply and sewerage components in Sicuani were delayed by more than 10 years, and the Project period was three times longer than planned. Due to price inflation over this period and expansion of the water treatment plants and sewage treatment plants and so forth, the Project cost was roughly 80% greater than planned. Accordingly, the Project efficiency was low. In Iquitos and Cusco, the project has realized water production and sewage treatment capacity greater than planned while expansion of the water supply and sewerage networks has been constructed mostly as planned. Accordingly, the Project has contributed to improvement of environmental and sanitary conditions as planned in both these cities. In Cusco, there has been major improvement in the water supply and sewerage coverage rates and water supply time as well as in prevention of pollution in the Huatanay River. On the other hand, in Iquitos, where issues remain concerning non-revenue water and water shortage continues, no major improvement has been witnessed in water supply services. In Sicuani, the water supply and sewerage facilities are not yet completed and had not started operating by the time of the ex-post evaluation. While the project effect is expected to be high in the water supply sector, judgment cannot be made concerning the sewerage sector where concerns exist over operation of the

sewage treatment plant. Summing up, effectiveness and impact of the Project have been high. In Cusco, there are no problems concerning operation and maintenance, and sustainability is high. In Iquitos, sustainability is low, as there are some minor issues in technical aspect and concerns in financial aspects. In Sicuani, since concerns remain over the sewage treatment plant in terms of institution, technology and finance, sustainability is low-fair. Overall, sustainability of the effects realized by the Project is fair.

In conclusion, the Project is evaluated to be partially satisfactory.

1. Project Description



Project locations

Distribution reservoir constructed at the Iquitos Sanitation Service Company

1.1 Background

In Peru, when the economy collapsed in the late 1980s, hardly any investment was carried out in the water supply and sanitation sector, and facilities became deteriorated. As more and more of the population moved into urban areas, the water supply coverage rate declined, the water supply capacity was unable to keep up with demand, and restrictions were placed on water supply time in many regional cities. The sewerage coverage rate was even lower than the water supply coverage rate, with almost half of all regional cities having no sewage treatment plants and untreated sewage being discharged into rivers.

The administration of President Fujimori (1990-2000) regarded water supply and sewerage improvement and expansion as an important policy issue. In 1992, it conducted reform of the sanitation sector. At this time, it established National Program of Potable Water and Sewerage (*Programa Nacional de Agua Potable y Alcantarillado*: hereinafter referred to as "PRONAP") under the Ministry of Presidency, and National Sanitation Services Supervisory (*Superintendencia Nacional de Servicios de Saneamiento*: hereinafter referred to as "SUNASS") under the Ministry of Economy and Finance. As a result of this reform, in regional cities, the regional governments started provision of water supply and sewerage services through SSCs,

etc. under technical support from PRONAP and supervision by SUNASS.

PRONAP compiled the National Water and Sewage Program in 1992 and started work on water supply and sewerage improvement and expansion with assistance from JICA and other donors. JICA gave assistance to Lima metropolitan area through three separate ODA Loan projects. Concerning regional cities, based on the city-based feasibility study that was implemented under support from the Inter-American Development Bank, it implemented the Provincial Cities Water Supply and Sewerage System Improvement and Expansion Project targeting the two cities of Piura and Chimbote in 1999.[1]

This Project, based on the feasibility study that was implemented under support from the Inter-American Development Bank against the background described above, was intended to implement water supply and sewerage improvement and expansion in three cities, i.e. Iquitos in Loreto Region, Cusco in Cusco Region, and Sicuani in Cusco Region. In response to the request for assistance by the Government of Peru, the fact-finding mission was dispatched in 1999, the ex-ante evaluation (review) was conducted, and loan agreement was signed in 2000.

1.2 Project Outline

To improve the water supply and sewerage coverage rate in the Peruvian regional cities of Iquitos, Cusco and Sicuani by means of improving and constructing water supply and sewerage facilities as well as enhancing capacity for water production and sewerage treatment, thereby contributing to improvement of environmental and sanitary conditions in the target area.

Loan Approved Amount / Disbursed Amount	7,636 million yen / 6,010 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	September 2000	
Terms and Conditions	Interest Rate	Water supply improvement and expansion: 1.7%, Sewerage improvement and expansion / consulting service: 0.75%
	Repayment period (Grace Period)	Water supply improvement and expansion: 25 years (7 years), Sewerage improvement and expansion / consulting service: 40 years (10 years)
	Conditions for Procurement	Water supply improvement and expansion: general untied, Sewerage improvement and expansion / consulting service: bilateral tied
Borrower / Executing Agencies	Republic of Peru / Ministry of Housing, Construction, and Sanitation (*Ministerio de Vivienda, Construcción y Saneamiento*: MVCS), National Urban Sanitation Program (*Programa Nacional de Saneamiento Urbano*: PNSU)	

[1] JICA provided loans for "Lima-Callao Metropolitan Area Water Supply and Sewerage Improvement Project" (1996), "Southern Lima Metropolitan Sewerage Improvement Project" (1996), and "Pomacocha-RioBlanco Water Resource Transfer Project (MARCA II)" (1997). The Inter-American Development Bank implemented feasibility studies in 36 out of 67 regional cities in Peru and offered funding for improvement of infrastructure in some of these.

Final Disbursement Date	January 2013
Main Contractor (Over 1 billion yen)	Water supply in Iquitos: Construtora Norberto Odebrecht (Brazil), China International Water & Electric Corporation (People's Republic of China) Waste water treatment plant in Cusco: COSAPI S.A. (Peru) Water supply and sewerage in Sicuani: COMSA (Peru)
Main Consultant (Over 100 million yen)	Iquitos and Sicuani: NJS Co., Ltd. (Japan), Cusco: Nippon Koei LAC (Japan)/Nippon Koei (Japan) (JV)
Related Projects	Provincial Cities Water Supply and Sewerage System Improvement and Expansion Project (ODA Loan, 1999)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan, Inc.)

2.2 Duration of Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Duration of the Study: July 2015-March 2017

Duration of the Field Survey: January 14-February 9, May 13-27, 2016

2.3 Constraints during the Evaluation Study

The water supply and sewerage facilities of the Project in Cusco were removed from the scope of the ODA Loan in 2004 following the start of the Project, and came to be constructed under funds by the Peruvian side. They remain within the scope of the Project activity. However, because they were constructed as a part of the series of water supply and sewerage construction works implemented by Cusco SSC (EPS SEDACUSCO S.A.)[2], it was not possible to fully clarify the detailed results of its implementation, i.e. scope, cost and implementation period of the Project. Part of the facilities were built by own funding in Iquitos and Sicuani as well, and it was not possible to obtain information on their cost, implementation period and number of new connections.

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

3.1 Relevance (Rating: ③[4])

3.1.1 Relevance to Development Plan of Peru

As was described in section 1.1 Background of the Project, at the time of the ex-ante evaluation (2000), the water supply and sewerage was an important policy area. At this time the administration of President Fujimori established PRONAP under the Ministry of Presidency,

[2] *Empresa Prestador de Servicios SEDACUSCO Sociedad Anónima*

[3] A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory

[4] ③: High, ②: Fair, ①: Low

carried out sanitation sector reform under the decentralization policy, developed a water sector development plan and was making efforts for water supply and sewerage improvement and expansion in local cities.

After that, the second presidency of Alan Garcia (2006-2011) greatly increased the amount of public sector investment in the water supply and sewerage sector under the slogan of "Water for All"[5]. In the mid-term strategy (planning period 2016-2021) that was prepared by Ministry of Housing, Construction and Sanitation (hereinafter referred to as "MVCS") in 2015, the strategic goal is "increased access to high-quality and sustainable water supply and sanitation services in urban and rural areas." Concerning water supply and sewerage improvement and expansion in local cities, the mid-term strategy indicates plans for strengthening of the operational capacity of the SSCs, participation by the private sector, measures to secure greater sustainability and so on.

In this way, the Project had high relevance to development plans both at the time of the ex-ante evaluation and the time of the ex-post evaluation.

3.1.2 Relevance to the Development Needs of Peru

As was described in section 1.1 Background of the Project, at the time of the ex-ante evaluation (2000), there was a great necessity for water supply and sewerage improvement and expansion in numerous local cities. In the three cities targeted by the Project, there were needs for water supply and sewerage improvement and expansion as described hereafter.

Iquitos (population in 1998: 390,000) is a core city in the Amazon region. Here, due to the influx of population that led to an increase in water demand, it became urgently necessary to improve the water supply coverage rate and supply time.

Cusco (population in 1998: 290,000) is Peru's top city for tourism. It had been developing groundwater resources under financial assistance from France, etc. However, in order for it to develop as a tourism city, it was necessary to improve the deteriorated water supply network, expand water supply to surrounding areas and increase supply time. In addition, the sewerage coverage rate was low and the sewage treatment rate was also low due to the insufficient capacity of existing treatment plant. As a result, water quality in the Huatanay River in the city had reached critical levels and there was concern over the impacts of this on agriculture via irrigation use of the river water.

Sicuani (population in 1998: 40,000) is a commercial city and transport hub. Its water supply coverage rate and water supply time were at a sufficient level. However, it was necessary to expand the water supply and sewerage network to new residential areas. Sewage was being discharged in the untreated state, so it was urgently necessary to construct a treatment plant.

[5] According to data of the MVCS, public sector investment in the water supply and sewerage sector was no greater than 0.1% of GNP until 2005, however, since 2009 it has been 0.6-0.8%.

As is described in the section on effectiveness, at the time of ex-post evaluation, water and sanitation facilities improved or constructed by the Project are playing an important role in providing water supply and sanitation services in each city. Accordingly, importance of the Project is also sustained at the time of the ex-post evaluation.

3.1.3 Relevance to Japan's ODA Policy

At the time of the ex-ante evaluation, priority sectors according to the Country Assistance Plan of the Japanese Government for Peru (2000) were poverty countermeasures, support for the social sector, development of the economic base, and environmental conservation. In the area of poverty countermeasures, the plan stated "concerning basic human needs (BHN), assistance will be advanced based on water supply and sewerage improvement and expansion in future" and proposed water pollution countermeasures in the field of environmental conservation. Accordingly, the Project had a high degree of relevance to Japan's ODA policies in Peru.

3.1.4 Appropriateness of the Project Planning and Approach

While the detailed design was performed in Sicuani more than 10 years after the completion of the feasibility study, the treatment method for the sewage treatment plant has been changed because the planned site area for the sewage treatment plant could not be obtained. Serious concerns have been raised regarding the operation and maintenance under the Sicuani SSC (EPS EMPSSAPAL S.A.)[6] that lacks both in technical competency and financial capacity, since the new treatment method requires more advanced techniques and a larger amount of the operation and maintenance expenditure compared to the treatment plant in the original plan. While this change had been carried out in accordance with the procedures applicable for public investment projects in Peru, neither the possible alternative sites nor the financial sustainability had been examined in order to avoid further delay on the project execution. An adequate consideration should have been given when a change of plan would possibly have serious impacts on the sustainability. However, this weakness is not considered to have significantly diminished the relevance of the Project as a whole. Therefore, it does not degrade the assessment of relevance.

Summing up, implementation of the Project was fully consistent with and relevant to the development policies and development needs of Peru and the aid policies of Japan.

[6] *Empresa Municipal Prestadora de Servicios de Saneamiento de las Provincias Alto Andinas Sociedad Anónima*

3.2 Efficiency (Rating: ①)

3.2.1 Outputs

In the Project, water supply improvement was implemented in Iquitos; water supply and sewerage improvement was implemented in Cusco; and water supply and sewerage improvement was implemented in Sicuani. The planned and actual outputs of the Project were as indicated in Table 1. As the facilities in this project are constructed to improve and expand existing water supply and sewage facilities in each city, they are scattered inside the city, and do not necessarily function together.

Table 1 Comparison of Planned and Actual Outputs

Plan	Actual
＜Iquitos water supply＞ Water production facilities: ・ Intake: reconditioning of intake 2 locations ・ Water treatment plant: new construction (production capacity 520 liter/sec) Water distribution facilities: ・ Clear water reservoirs: new construction 2 locations, repair 1 location ・ Water transmission pipeline: expansion and repair 18 kilometers ・ Pumping stations: new construction 1 location, repair 3 locations ・ Water distribution reservoirs: new construction 10 locations, repair 1 location ・ Distribution mains and distribution network: 187 kilometers ・ Connections: new construction 11,388, meter installation 11,388, repair 3,594	(completed in 2012) Water production facilities: ・ Intake: mostly as planned ・ Water treatment plant: new construction (production capacity: 750 liter/sec) Water distribution facilities: ・ Clear water reservoirs: new construction 3 locations, repair 1 location [1)] ・ Water transmission pipeline: expansion and repair 15 kilometers [2)] ・ Pumping stations: new construction 1 location, rehabilitation 3 locations ・ Water distribution reservoirs: new construction 10 locations, repair1 location ・ Distribution mains and distribution network: 135 kilometers ・ Connections: new construction 11,084, repairs 1,348, meter installations 11,388 ・ Introduction of SCADA system
＜Cusco water supply＞ Water distribution facilities: ・ Water distribution reservoirs: new construction 4 locations ・ Pumping stations: new construction and reconstruction 3 locations ・ Water transmission pipeline: new construction 26 kilometers ・ Water distribution network: new construction 16 districts, 29 kilometers ・ Connections: new construction 3,564 (including meters)	(completed in 2015) Water distribution facilities: ・ Water distribution reservoirs: new construction 1 location ・ Pumping stations: new construction and reconstruction 2 locations ・ Water transmission pipeline: partially implemented (implemented 9 kilometers out of 26 kilometers, not implemented 8 kilometers; concerning the remaining 9 kilometers, the planned locations and implementation situation are unclear). ・ Water distribution network: 16 districts (extension is unclear) ・ Connections: new 3,564 or more
＜Cusco sewerage＞ Sewage collection facilities: ・ Sewerage main: 15 kilometers ・ Secondary collector: 16 kilometers ・ Collector network: 16 districts, 23	(completed in 2014) Sewage collection facilities: ・ Sewerage main: 13 kilometers ・ Secondary collector: 14 kilometers ・ Collector network: 15 districts, extension

kilometers ・ Connections: new construction 7,190 Sewage treatment facilities: ・ Treatment plant: 300 liter/sec, oxidation pond system ・ Untreated sewerage conveyance pipeline to the new treatment plant: 7 kilometers	unclear ・ Connections: unclear Sewage treatment facilities: ・ Treatment plant: 460 liter/sec, trickling filter system ・ Untreated sewerage conveyance pipeline to the new treatment plant: none
＜Sicuani water supply＞ Water production facilities: ・ Water intake and conduction facilities: rehabilitation (2 locations, springs) Water distribution facilities: ・ Water distribution reservoirs: new construction 2 locations, rehabilitation 2 locations ・ Pumping stations: new construction 2 locations ・ Chlorine injection system (2 locations) ・ Water transmission pipeline and distribution mains: 6 kilometers ・ Water distribution network: expansion 6 districts, 19 kilometers	(completed in 2016) Water production facilities: ・ Water intake and conduction facilities: rehabilitation (3 locations, springs) Water distribution facilities: ・ Water distribution reservoirs: new construction 2 locations, rehabilitation 2 locations ・ Pumping stations: new construction 2 locations ・ Chlorine injection system (1 location) ・ Water transmission pipeline and distribution mains: combined with the water distribution network 17 kilometers (plan when the contract was signed; actual situation unclear) ・ Water distribution network: expansion 6 [3)] districts
＜Sicuani sewerage＞ Sewage collection facilities: ・ Sewerage main and collector network: 21 kilometers ・ Pumping stations: 1 location ・ Connections: 7 districts, new 2,125 Sewage treatment facilities: ・ Treatment plant: 77 liter/sec, oxidation pond system	(completed in 2016) Sewage collection facilities: ・ Sewerage main and collector network: 20 kilometers (final result unknown) ・ Pumping stations: 2 locations ・ Connections: 8 districts [3)], (number of new connections is unknown) Sewage treatment facilities: ・ Treatment plant: 80 liter/sec, anaerobic lagoon and trickling filter combined system

Source: Materials provided by JICA, MVCS, and SSC in each city

Notes: 1) Construction of one distribution reservoir and rehabilitation of one distribution reservoir implemented by the Peruvian fund are included.
2) Length of pipelines for one distribution reservoir implemented by the Peruvian fund is not included.
3) 5 districts of water supply network expansion and 5 districts of collector network expansion implemented by the Peruvian fund are included.

After the signing of the loan agreement in 2000, implementation of the Project using ODA Loan was suspended until 2002 due to changes of government that took place twice and the related reorganization of ministries. After 2002, the Project was implemented in Iquitos, Cuzco, and Sicuani, in this order (for details, see "3.2.2.2 Project Period"). The circumstances of implementation in each city, change of project scope and quality of outputs are explained bellow.

（1） Iquitos

In Iquitos, it was planned in the water supply sector to increase water production through rehabilitating water intake facilities and constructing a water treatment plant (adjacent to the existing water treatment plant), and to improve water distribution facilities including the

construction of water distribution reservoirs. Among the planned project scope, one distribution reservoir was constructed and one clear water reservoir was rehabilitated by their own funding during the period when utilization of ODA Loan was suspended. Thereafter, because of funding restrictions that arose due to price inflation, etc. following the loan agreement, the priority components of the planned works excluding the above were implemented between 2006-2008. After that, part of the Project work was assigned to Cusco SSC for implementation under its own funds (details are given later), and as a result, part of the ODA Loan was freed up, allowing the suspended Project works of Iquitos to be additionally implemented between 2010-2012. The main revisions in the Project scope were as follows:

- According to updating of the population forecast, the water treatment plant production capacity was increased.
- In the additional works, the SCADA system was introduced to water supply[7].

Out of the above changes, the SCADA system has so far never been operated because of frequent breakdown of measuring instruments etc. of the system due to lightning strike and difficulties in repair works. It can be said that facilities had not been designed to cope with the harsh local weather conditions and the operation and maintenance capacity had not been thoroughly examined. The other changes are considered to be appropriate.

Water intake (left) and treatment plant (right) in Iquitos

According to Iquitos SSC (EPS SEDAROLETO S.A.)[8], among the installations provided by the Project, many valves have been damaged before the expiration of their service

[7] SCADA (Supervisory Control And Data Acquisition) system is a type of industrial control system that entails system monitoring and process control by computer. In Iquitos, a system was introduced for a comprehensive monitoring on water level and flow rate data at water intakes, purification plants and distribution reservoirs.

[8] *Empresa Prestador de Servicios SEDALORETO Sociedad Anónima*

life. Iquitos SSC also points out that the panels of the flocculation tank in the water treatment plant were installed according to the specifications in the detailed design, however, due to the poor material quality, many panels were damaged and taken out, and this has led to lower treatment efficiency.

（２） Cusco[9]

In Cusco, in the water supply sector, the plan was to construct facilities for transmitting and distributing water in the city from the water production facilities (groundwater) that were constructed in 2000, and to expand the water distribution networks in the city. In the sewerage sector, the plan was to construct sewerage mains, collector networks and sewage treatment plant based on the oxidation pond system.

In the water supply sector, having acquired a new water source, because it was necessary to speed up construction of water transmission and distribution facilities, Cusco SSC started work on construction of part of the facilities under its own funds during the period of suspension of utilization of ODA Loan. However, because the financial conditions of Cusco SSC temporarily deteriorated in 2002-2003, the SSC was careful about constructing facilities with the ODA Loan transferred through the central government. Furthermore, it obtained financial support partially from the MVCS for construction of Huatanay interceptor, which is a key sewer main. Against this background, in 2004 agreement was reached between the MVCS, Cusco SSC and JICA that the loan fund would be used only for construction of the sewage treatment plant.

Concerning the sewage treatment plant, it was difficult to purchase the originally planned land because there were so many landowners on the site. Therefore, it was decided to construct a plant based on the trickling filter system, which requires less space than the oxidation pond system, on the site of the existing treatment plant. As a result, it was no longer necessary to construct a conveyance pipeline to carry collected sewage to the new treatment plant. The treatment capacity of the treatment plant was increased to enable the plant to respond to demand up to 2024 based on the revised population forecast. Also, at the request of Cusco SSC, digestion tanks, which enable part of the excess sludge to be changed to combustible gas and thereby reduce the quantity of excess sludge, were added.

In the water supply component, water distribution network expansion was implemented in 16 locations as planned, however, work on the water distribution facilities was only partially implemented. This was because the necessity to construct water distribution reservoirs and pumping stations was partially eliminated due to revision of the routes of water

[9] As was indicated in section 2.3 Constraints during the Evaluation Study, since the water supply and sewerage facilities in Cusco were constructed as part of the series of water supply and sewerage construction works implemented by Cusco SSC, it was not possible to fully clarify the detailed results of the Project (scope, cost and implementation period).

transmission and distribution. Construction of the sewage collection facilities has generally been implemented according to plan by Cusco SSC in numerous projects until now. It should be also noted that, concerning the water distribution facilities and sewage collection facilities, Cusco SSC has implemented numerous works outside the scope of the Project.

Waste Water Treatment Plant (left) and SCADA system for the Waste Water Treatment Plant (right) in Cusco

（３） Sicuani

In Sicuani, in the water supply sector, the plan was to improve water distribution pressure in high-altitude districts through construction of water distribution reservoirs, and to expand the water distribution network to newly constructed residential districts. In the sewerage sector, the plan was to construct a sewage treatment plant and a new sewerage main, and to expand the collector network to new residential districts.

In Sicuani, an opposition campaign arose among residents who were afraid that the implementation of water supply and sewerage improvement and expansion using ODA Loan would lead to privatization of the utility and large increases in water tariffs, and this developed into a political issue. Moreover, because Sicuani SSC faced a difficult financial situation and could not obtain support from the local government, it was unable to make a decision on immediately utilizing ODA Loan following the end of its suspension. In 2007, the Sicuani SSC decided to utilize the loan for the consulting service and commenced detailed design. However, due to further escalation in public opposition to the ODA Loan, in 2009 agreement was reached between the MVCS, Sicuani SSC and JICA to use the national budget rather than the loan for construction. The construction work by the national budget was started in December 2012 under a single contract that also included both water supply and sewerage components, and it was scheduled to be completed in June 2016[10].

[10] According to the information obtained after the second field trip, the construction works have been completed in July 2016 and trial operation was commenced.

The Project scope was finalized by conducting detailed design under the consulting service based on the plan at the time of appraisal. There were following major changes in this stage, as well as during the implementation phase.

- Due to the delay in the implementation utilizing ODA Loan, the scope of the Project was downsized as Sicuani SSC and Sicuani municipal government conducted expansion through its own funding in five out of the six districts where water distribution network expansion was planned and in five out of seven districts where collector network expansion was planned. Expansion of the remaining districts was implemented by the national budget. Also, one more district of collector network expansion was added to the project scope. These changes were necessary and appropriate in accordance with expansion of the urban area.
- It was scheduled to implement rehabilitation of water intake at two locations. However, in reality, rehabilitation (including expansion of water conduction capacity) was conducted at two locations and protection works (construction of embankment and fence) were implemented at one location. While it was found at the time of the detailed design that the arsenic concentration exceeded the standard which was revised to be stricter in 2010, after the commencement of the implementation, the protection works were implemented as planned. However, the water source in question was no longer used and, as a result, the protection works were not necessary.
- Concerning the treatment plant, because only around one eighth (4.2ha) of the planned site area (32ha) could be secured[11], anaerobic lagoon and trickling filter combined system, which can conduct treatment on a smaller area than the oxidation pond that was planned originally, was adopted[12]. Due to adoption of this treatment method, operation and maintenance of the sewage treatment plant required more sophisticated technology compared to the original plan and became more expensive. However, no consideration of alternative sites or financial analysis was made in this process, and serious challenges were left in financial sustainability[13]. Therefore, there is room for doubt on the appropriateness of this change.
- In the implementation stage, the filter medium was changed from stone to plastic at the request of Sicuani SSC. This change was intended to further improve the treatment efficiency, while it led to higher cost and a longer implementation period, and doubt

[11] According to Sicuani SSC, the initially intended site was common land in a village, for which an agreement was reached in 1996 to sell it as the site for the sewage treatment plant However, during more than 10 years of project delays, part of the land fell into private ownership and negotiations became difficult.

[12] See section 3.1.4 Appropriateness of the Project Planning and Approach.

[13] According to the Sicuani SSC and MVCS, it was thought to look for another site again, but the change of the site requires 3-4 years for the investigation and approval process according to Peru's public investment system. For this reason, construction at the originally planned site was decided in order to avoid further delays in implementation.

remains over its necessity.[14]

- Following the start of construction, the consultant at its own discretion changed the position of the pretreatment facilities in the sewage treatment plant. This triggered an opposition movement among local residents that resulted in them occupying the treatment plant. Following negotiations with the residents, the pretreatment facilities were restored to their original position, and odor prevention equipment, etc. was additionally installed in accordance with the request of local residents.[15]
- For the detailed design, designing works of the equipment to receive transmitted electricity for the pumping stations and the sewage treatment plant were included in the original plan were not produced. They were carried out during the construction stage. In implementation, the actual pipeline works costed almost more than double of the original plan. Furthermore, as the amount of earth works for sewage treatment plant construction was more than estimated, a large additional cost was incurred in the implementation stage. According to the interview during the field visit, the Sicuani SSC believes that the estimation by detailed design on the quantity of water transmission, distribution and sewerage mains and collector network as well as the earth work was not accurate.

Water distribution reservoir (left) and waste water treatment plant (right) under construction in Sicuani

[14] This change was approved due to reasons including easier implementations of the construction work and the operation and maintenance, the higher treatment efficiency, and the ease of future expansion, while it is not believed to be a change requiring an urgent action. Meanwhile, it had caused the increased cost and the longer time to complete the construction, as the plastic filter material needed to be imported.

[15] According to the officer in charge of MVCS and Sicuani SSC, the odor prevention equipment is not required based on the environmental norms.

The implementation stage showed some inefficiency, for example, it was necessary to reconstruct the water distribution reservoirs due to poor work quality, and the reservoir pumps had to be re-procured because they did not satisfy the necessary performance. However, because the works were still not finished at the time of site visit of the ex-post evaluation, it was not possible to make a final judgment on the quality of the works.

Sicuani SSC thinks that the poor quality of the detailed design led to higher working costs and a longer working period, and the changes to the plan made by the consultant without approval of the SSC triggered an opposition movement by local residents and also caused higher working costs and a longer working period. Therefore, Sicuani SSC is not satisfied with the performance of the consultant.[16]

As described above, it can be pointed out that there were certain aspects where the quality in managing and executing the construction was low in this project, especially in Iquitos and Sicuani.[17]

3.2.2 Project Inputs

3.2.2.1 Project Cost

Table 2 shows the planned and actual Project cost. The ODA Loan was not used for the consulting service and construction of the water supply and sewage collection facilities in Cusco, nor for construction of water supply and sewerage facilities in Sicuani. Therefore, only 79% (6,010 million yen) of the planned ODA Loan amount (7,636 million yen) was used. However, excluding the cost for water supply and sewage collection facilities in Cusco for which the actual amount is unknown (planned amount: 2,521 million yen), the actual project cost of 15,216 million yen was 178% of the planned amount of 8,554 million yen, largely exceeding the planned amount. Accordingly, although use of the ODA Loan declined, much of the extra project cost had to be covered by the Peruvian side (budget of the MVCS: total 9,206 million yen for those components under comparison). The large increase in the project cost was caused by revisions in the project scope resulting from expansion in the scale of sewage treatment plants and changes to the treatment method in Cusco and Sicuani, and high price inflation that arose during the delay in implementation by 5-11 years in each city[18].

[16] Due to the opposition movement by local residents, the Project cost in Sicuani increased by 30% or more. The working period was extended by some 15 months due to suspension of civil works, change of the position of pretreatment facility and addition of odor treatment facility, etc.

[17] This has impacts on the sustainability (regarding the operation and maintenance aspects) in Iquitos, and on both the financial sustainability and the efficiency in Sicuani.

[18] The consumer price index in Peru increased by 50% or more between 1999, when the Project costs were estimated, and 2015.

Table 2 Planned and Actual Project Cost

(Unit: million yen)

	Planned			Actual		
	Total	ODA Loan	Peruvian side	Total	ODA Loan	Peruvian side
Iquitos water supply*	2,026	2,026	0	5,396 [2)]	3,934	1,462
Cusco water supply	530	530	0	Unknown [1)]	0	Unknown
Cusco sewerage	1,991	1,991	0	Unknown [1)]	1,175	Unknown
(Sewage treatment facilities*)	(894)	(894)	(0)	(2,603)	(1,175)	(1,428)
Sicuani water supply / sewerage*	1,138	1,138	0	2,987 [2)]	0	2,987
Price inflation, physical contingency*	1,427	649	778	0	0	0
Consulting service* (detail design, procurement support, supervision)	1,302	1,302	0	1,722	901	821
Land acquisition and tax*	1,767	0	1,767	2,508	0	2,508
Total (*Total)	10,181 (8,554)	7,636 (6,009)	2,545 (2,545)	Unknown (15,216)	6,010 (6,010)	Unknown (9,206)

Source: materials provided by JICA and the MVCS

Note: 1) Out of the water supply and sewerage works in Cusco, sewage collection facilities (collector network) have been constructed as a part of numerous projects by Cusco SSC since 2000. As a result, it was not possible to calculate the actual cost of works.

2) Cost of the facilities constructed in Iquitos and Sicuani using its own funds during the suspension period of ODA Loan utilization is not included. Project cost in Sicuani is the planned amount as of October 2015. The estimation standard for the planned amount is September 1999.

Exchange rate (Planned) US$1 = 113.5 yen, 1 Nuevo Sol = 34.0 yen
(Actual) US$1 = 101.0 yen (actually applied rate)
1 Nuevo Sol = 32.7-38.4 yen (average rate during the contract term)

3.2.2.2 Project Period

The loan agreement for the Project was signed in September 2000. The Project was scheduled to be completed in May 2005, however, in reality, as is shown in the Figure 1, it has been implemented in the order of Iquitos, Cusco and Sicuani. In Sicuani, it is not yet completed as of May, 2016[19]. The planned project period was 57 months (September 2000-May 2005). However, in reality it was more than 189 months (September 2000-May 2016), rising at least to 332% of the planned period, largely exceeding the planed period. In line with this delay, the final disbursement date of ODA Loan was extended two times[20]. The main reasons for the large increase of the project period were as follows:

- After the loan agreement was signed in 2000, implementation was suspended until 2002 because there were two changes of government and consequential reorganization of ministries and government offices. Also, in 2001 the manpower of the executing agency PRONAP (at the time) was greatly reduced, resulting in a major decline in operation and supervision capacity.

[19] Refer footnote 10.

[20] The final disbursement date was January 2008 (seven years after the loan agreement became effective). However, it was extended to October 2010, and extended again until December 2012.

- Due to the abovementioned economic and political turmoil and the effects of decentralization that was advanced from 2002 onwards, the economic condition of the SSCs deteriorated, and difficulties were encountered in securing counterpart funding by local governments[21].
- In Iquitos, decision was made to implement the Project in 2003 when it appeared that the counterpart funding by local government could be secured. Thereafter, the procurement and start of construction works were delayed because a major increase in costs became apparent through the detailed design and it was necessary to review the scope of the Project. After that, additional works were implemented under the ODA Loan that became available. There was no major delay in the works itself.
- In Cusco, implementation of the Project was decided upon agreeing to change the funding arrangement by excluding the water supply and sewage collection facilities from the targets of the loan fund in 2004. After that, four years were spent on additional studies (financed outside the scope of the ODA loan) to revise the plans for the sewage treatment plant and re-examination by the Government of Peru[22]. The consulting service was procured in 2009, and the construction works were procured in 2010. Concerning the procurement of construction works, substantial time was spent on preparing the tender documents and negotiating the contract, and the works were started in March 2012. There was no major delay in the works itself.
- In Sicuani, because the local government was not willing to bear its own financial resources, no decision was made on project implementation until 2007 when the local government was changed. The consulting service procurement procedure was commenced in 2008. However, an opposition movement arose among residents who were unhappy about the Project utilizing an ODA Loan. It was not possible to sign the contract until a decision to use the national budget in construction was made in 2009. In addition, the detailed design period increased due to the long time required to acquire the sewage treatment plant site. The works were started in 2012 with the aim of finishing them in 12 months. However, the work schedule was extended some 29 months due to the following factors related to construction of the sewage treatment plant. Moreover, in Sicuani, because the water supply and sewerage works were conducted under a single contract, completion of the water supply facilities was also delayed[23].

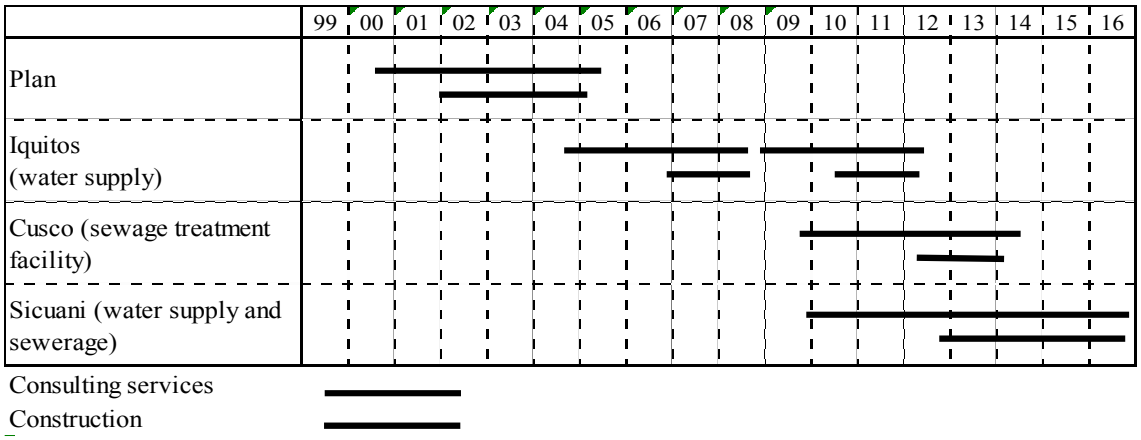
[21] Deterioration in the financial standing of the local government that was the shareholder also had an impact on the SSC.

[22] In Cusco, because the scope of the ODA Loan was limited to the sewage treatment plant, the Project was required to once more pass through the domestic review process that was revised in 2004. In Iquitos and Sicuani, this process was not demanded.

[23] In works contracts in Sicuani, it is possible to impose penalty on contractors that cause delays in the works

- Delay in acquiring land for the access road to the treatment plant (5.5 months)
- Change to the filtrate medium in the treatment plant (6.2 months)
- Addition of the equipment to receive transmitted electricity that was missing in the detailed design (2.0 months)
- Suspension of works due to opposition by residents to the changed location of pretreatment facilities (6.8 months)
- Further change of the location of pretreatment facilities and addition of deodorization equipment (8.1 months)

Figure 1 Planned and Actual Project Period in Each City (1999-2016)



Source: Materials provided by JICA and the MVCS
Note: Period of the construction through own funding in Iquitos and Sicuani during the suspension period of ODA loan utilization is not indicated. The planned construction period was approximately three years in Iquitos and approximately two years in Cusco and Sicuani.

3.2.3 Results of Calculations of Internal Rates of Return (reference only)

Targeting the water supply plant of Iquitos, the financial internal rate of return was recalculated assuming the Project life to be 30 years, the costs to comprise construction cost and operation and maintenance cost, and the benefit to be revenue from water tariffs. As a result, the financial internal rate of return (FIRR) was calculated to be 2.0%, far lower than the initially planned value of 16.8%. The economic internal rate of return (EIRR) calculated based on the cost excluding taxes from the cost was 5.3% (there was no planned value).

The main reason why the FIRR of the water supply in Iquitos was less than planned was due to the fact that the project cost was more than doubled. Incidentally, not enough data was obtained to conduct recalculation for Cusco and Sicuani and no recalculation was

schedule. However, the reference works period was only set regarding completion of the sewage treatment plant, and it was only stipulated that the water supply and sewage collection facilities should be finished by the time of completion of the sewage treatment plant. If the construction period based on partial completion and partial delivery is set, the contractor would have hurried to finish the works. However, because no such target was defined, the water supply works took longer than necessary.

conducted.

As is described above, both the project cost and project period significantly exceeded the plan. Therefore, efficiency of the project is low.

3.3 Effectiveness[24] (Rating: ③)

3.3.1 Quantitative Effects (Operational and Effect Indicators)

The objectives of the Project were to improve the water supply and sewerage coverage rate and to strengthen water supply and sewage treatment. Table 3 shows the targets that were proposed for each city at the time of review, and the actual achievements. Also, Table 4 and 5 show the level of achievement of other indicators before and after the Project regarding performances of water and sanitation services in each city. The post-project performance of these indicators reflects not only the effects of the Project but also effects of numerous other projects that have been implemented by the SSCs in each city.

Table 3 Achievement of Targets Adopted at the Time of Appraisal

	Increase in water production capacity Increase in sewage treatment capacity (operational indicator)		Increase in service population of water supply and sewerage since 1995 (effect indicator)	
	Planned (2010)	Actual (ratio compared to plan)	Planned [(a)] (2010)	Actual (ratio compared to plan)
Iquitos water supply	520 liter/sec	750 liter/sec[(b)] (144%)	225,000	176,000 (2013) (78%)
Cusco water supply [(c)]	-	-	135,000	129,000 (2013) (96%)
Cusco sewerage	300 liter/sec	506 liter/sec[(d)] (169%)	135,000	222,000 (2013) (164%)
Sicuani water supply	18 liter/sec	40 liter/sec[(e)] (222%)	10,000	13,000 (2012) (130%)
Sicuani sewerage	77 liter/sec	80 liter/sec[(f)] (104%)	13,000	17,000 (2012) (131%)

Source: Materials provided by JICA and each city's SSC

Note: The "Increase in water production capacity" and "Increase in sewage treatment capacity" show effects derived from the Project alone, while, the "Increase in service population of water supply and sewerage" reflect not only the effects of the Project but also numerous other projects that have been implemented by the SSC in each city. Concerning the actual "Increase in water production capacity" and "Increase in sewage treatment capacity," the higher values out of the realized design equipment capacity and maximum production or treatment volume achieved so far were used. For details, see (b)-(f) below.

(a) Plan values were set for 2010, however, the calculation method was not specified and the planned values for 2011 onwards were unclear. Therefore, planned figures for 2010 were used.
(b) Design capacity after modification of plan (Construction was completed in 2008. Maximum production recorded in 2014 746 liter/sec.)
(c) Although a target figure of 420 liter/sec was indicated for water supply, it must be a mistake as no such components are included in the Project.
(d) Because treatment performance (2015) exceeds the equipment capacity (460 liter/sec) after modification of plan, the treatment performance was adopted.
(e) Results of test conducted by Sicuani SSC in 2015 (the facilities were completed but have not started operation).
(f) Because facilities were not completed, the designed capacity was adopted.

[24] Effectiveness is rated upon also taking impact into account.

Table 4 Other Indicators concerning Water Supply

	Iquitos	Cusco	Sicuani (before Project completion)
Water production*	1995: 620 liter/sec 2013-15: 1,015 liter/sec	1995: 326 liter/sec 2013-15: 644 liter/sec	1995: Approx. 60 liter/sec 2013-15: 69 liter/sec
Water supply population**	1995: 157,000 2013: 333,000	1995: 145,000 2013: 274,000	1995: 25,000 2012: 38,000
Coverage rate**	1998: 68% 2015: 81%	1998: 73% 2014: 98%	1998: 88% 2015: 86%
Population with new connections**	Approximately 60,000	Approximately 15,000	(not known)
Water supply hours**	1998: 13 hours 2013-15: 13.6 hours	1998: 11 hours 2013-15: 20.5 hours	1998: 21 hours 2012: 23.8 hours
Water pressure**[25]	Approx. 9 meter water column	30 meter water column or more	Approx. 15 meter water column
Non-revenue water rate*	2015: 56%	1995: 38% 2013-15: 35%	1995: 57% 2015: 44%

Source: Materials provided by JICA, Each city's SSC
Note: (*) Operational Indicator, (**) Effect Indicator
The post-project achievement (2013 -) of the above indicators reflect also other projects which have been implemented in each city, excluding the "water production " of Iquitos and Sicuani and the "population with new connections (estimated based on the number of new connections)" in each city.

Table 5 Other Indicators concerning Sewerage

	Cusco	Sicuani (before Project completion)
Sewage treatment volume*	2015: 506 liter/sec	80 liter/sec (planned)
Population served**	1995: 68,000 people 2013: 290,000 people	1995: 20,000 people 2012: 37,000 people
Coverage rate**	1998: 46% 2014: 80%	1998: 88% 2012: 84%
New connections**	Approximately 28,000 people	(not known)
Treatment efficiency*	BOD removal rate: 90% (2015) Before treatment BOD: 445mg/liter After treatment BOD: 47mg/liter	BOD removal rate: 90% (planned) Before treatment BOD: 390mg/liter After treatment BOD: 15mg/liter

Source: Materials provided by JICA, Each city's SSC
Note: (*) Operational Indicator (**) Effect Indicator
The post-project performance of these indicators (2013 onwards) includes the effects of other projects implemented by each city, except for the sewage treatment capacity of Cusco, the new connection population in each city (estimated based on the length of installed end sewers), and the treatment efficiency in Cusco.

As shown in Table 3, the planned targets for the improvement of water supply capacity and sewage treatment capacity were achieved in all cities, while increase in service population of water supply and sewerage (population that receive water and sewerage service) was achieved except for water supply in Iquitos and Cusco. The improvement of water supply capacity and sewage treatment capacity was achieved by the facilities that were constructed in the Project, while, much of the increase in the target population of water supply and sewerage

[25] Meter water column is the unit of pressure that can support a water column of 1 meter. The standard in Peru is 15-50 meter water column.

was not realized as a direct result of the Project, but rather due to the effects of the numerous projects that have been implemented by the SSCs, etc. in each city[26]. Therefore, in the ex-post evaluation, "increase in the service population of water supply and sewerage" (Table 3) was treated as a reference indicator, and the effectiveness of the Project in each city was judged based on selected indicators shown in Table 3, 4, 5 and the manifestation of the specific effects mentioned in 3.3.2 that were anticipated from the Project.

3.3.2 Project Effects in the Target Cities

（1） Iquitos water supply

In Iquitos, the main issues concerned were increase in water production, equalization of water distribution and expansion of the water supply area.

Thanks to the rehabilitation of water intake and conduction facilities and construction of the new water treatment plant, which was a bottleneck for water production, the water supply capacity was increased to 750 liter/sec which was higher than the planned 520 liter/sec. The water production volume before the Project was approximately 620 liter/sec in the old water treatment plant, while the average water production volume of the old and new water treatment plants combined between 2013-2015 was approximately 400 liter/sec higher than this at 1,015 liter/sec. The water production volume of the new water treatment plant is 719 liter/sec (average between 2013-2015) and the facility utilization rate is 96%. According to Iquitos SSC, water quality of the water treatment plant satisfies all standards including residual chlorine and turbidity and there is no problem[27]. Accordingly, the expected effects of the Project in terms of increasing water production were achieved more than planned. On the other hand, in Iquitos, because the meter installation rate is low at 41% (2015) and there are many illegal connections to the water supply, the ratio of non-revenue water is high at 56% (2015). The Project is believed to have contributed to reducing non-revenue water (increasing revenue water) by renewing water distribution pipes in central areas and installing water meters[28].

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[26] In Cusco, development of water sources not included in the Project facilitated major increase in the water supply population. Moreover, the water supply and sewerage service populations in each city increased thanks to ongoing expansion of water transmission and distribution networks and sewerage networks and increase in the number of connections in line with population growth. The Project was only a small part of such development. In particular, almost all additional connections to existing water transmission and distribution networks and sewerage networks were realized outside of the Project. The increases in water supply population and sewerage service population that were presented at the time of appraisal were not indicated as targets for the Project alone, but rather as goals for the overall region to be achieved through the combined effort of numerous projects.

[27] However, at the time of the field survey in the ex-post evaluation, as the raw water had high chromaticity and some of the facilities at the water treatment plant were undergoing repair, there was slight turbidity and color in the water. This was also reflected in the results of the survey of beneficiaries.

[28] Due to the renewal of deteriorated distribution pipes and replacement of house connections in line with the installation of meters, water leaks are reduced and non-revenue water is reduced. The meters that were installed in the Project correspond to 48% of all the water meters installed in the city. Iquitos SSC has been striving to reduce the non-revenue water rate through adjusting its water distribution program in recent years. Ever since a non-revenue water rate of 63% was recorded in 2013, the rate has been going down. In the first three months of 2016, the non-revenue water rate was 55%.

Concerning water distribution, before the start of the Project, because there were no distribution reservoirs, water was distributed to all city districts by direct pumping from the old water treatment plant. As a result, water pressure was insufficient at the ends of distribution network, and uniform water distribution could not be realized. According to Iquitos SSC, in the Project, because numerous distribution reservoirs were constructed, it became possible to secure enough water pressure even in areas far away from the water treatment plant and conduct uniform water distribution over a wide area. Because the facilities constructed in the Project are fully utilized and have contributed to improving water production and distribution, it is thought that the anticipated Project effects regarding improvement of water transmission and distribution have been achieved. However, the average water supply hours per day has remained almost the same (13 hours in 1998 versus 13.6 hours on average between 2013-2015), and the recent water pressure has been low at around 9 meters water column on average. Due to the limited capacity of water intake which is influenced by water level of the river etc., water production has been unable to keep pace with the increase in water supply population, and since effective water volume is limited (high non-revenue water rate), the water shortage is continuing[29].

The water supply service population increased from 157,000 (1995) to 333,000 (2013), and the water supply coverage rate increased from 68% (1998) to 81% (2015). Through the Project, new connections were established to approximately 11,000 households (approximately 60,000 people). This is almost as planned and is equivalent to 34% of the increase in water supply service population of 176,000. Therefore, it is thought that the Project target concerning increase of water supply service population has been almost achieved.

Accordingly, the anticipated Project effects regarding water supply in Iquitos have been achieved more than was planned, and the Project effectiveness is deemed to have been "very high".

（２） Cusco water supply

In Cusco, the main issues in water supply were increase of service population, coverage rate and water supply hours. Improvements have been seen in these areas (Table 4) thanks to the synergistic effect by securing new water sources and construction of water distribution facilities including those in the Project[30].

As shown in the Table 4, the water supply service population increased from 145,000 (1995) to 274,000 (2013), and the water supply coverage rate increased from 73% (1998) to 98% (2014). The Project contributed to this by making new connections to approximately 3,500

[29] Whereas the water supply population almost doubled between 1995 and 2013, the amount of water production only increased by approximately 70%.

[30] The water sources that were constructed in 2000 account for 42% of total water production volume in Cusco (2013-2015).

households (approximately 15,000 people). The number of these new connections was roughly as planned and accounted for 12% of the increase in the water supply population of 129,000. Accordingly, it is deemed that the improvements in water supply population and coverage rate in Cusco were roughly as planned.

The water supply time increased greatly from 11 hours (1998) to 20.5 hours (average between 2013-2015). The recent water pressure has been appropriate at 30 meters water column or more. It is thought that the Project contributed to this effect through constructing water transmission pipeline and water distribution reservoirs. However, because part of the Project location could not be confirmed (both in planning and implementation) and the SSC has constructed numerous facilities outside of the Project, it is difficult to identify the specific contribution of the Project. However, considering that all the facilities needed were constructed and being utilized[31], it is deemed that the Project has adequately contributed to improvement of water distribution. Incidentally, the non-revenue water rate improved only slightly from 38% (1995) to 35% (average between 2013-2015). The Project is considered to have contributed to this by installing 3,564 new meters (approximately 5% of all connections).

Accordingly, the anticipated Project effects regarding water supply in Cusco have more or less been achieved, and the Project effectiveness is deemed to have been “high”.

（３） Cusco sewerage

Concerning sewerage in Cusco, the main issues were increase of the sewerage service population and coverage rate, and reduction of discharge of untreated sewage into the Huatanay River where pollution was a serious problem.

The sewerage service population increased from 68,000 (1995) to 290,000 (2013), and the sewerage coverage rate increased from 46% (1998) to 80% (2015) (Table 3, 4). The Project made contribution to this, as it was more or less implemented as planned concerning construction of sewerage mains (27 kilometers out of the planned 31 kilometers), and expansion of the sewerage network in 15 out of the 16 planned districts. The Project directly resulted in new connections to around 7,000 households (28,000 people), equivalent to 13% of the increase in sewerage service population of 222,000[32]. Therefore, it is thought that the Project target concerning increase of sewerage service population and sewerage coverage rate was more or less achieved as planned.

The constructed sewage treatment plant achieved the capacity target, showing a

[31] See 3.2.1 Outputs (2) Cusco.

[32] There are water supply and sewerage schemes independently operated by community organizations around the service area of Cusco SSC, and the Project’s sewage treatment plant receives some of the sewage from them. Total population served is estimated as much as 150,000. However, there is no clear agreement between the SSC and these community organizations concerning acceptance of sewage and no data that allows the quantity of received sewage to be estimated. Also, no sewerage tariffs are levied. It was also predicted in the planning stage that sewage would be received from these areas, however, it is possible that more sewage than planned is being received due to the rapid increase of population in the surrounding areas of Cusco.

sewage treatment flow of 506 liter/sec (2015, 169% of the planned value) compared to the planned flow of 300 liter/sec. The BOD concentration after treatment was 47 mg/liter (2015), not reaching the planned level in the detailed design of 30mg/liter due to more-than-planned quantity of flow, while, the treatment efficiency is sufficiently high at 90% as planned. Before the Project, BOD load of approximately 59 g/second (2012) was being treated in the old treatment plant. However, at the time of the detailed design, it was planned for the new treatment plant to treat 111 g/second of BOD load. In reality, BOD load of approximately 201 g/second, equivalent to 181% of the planned level, was treated in 2015, and the amount of BOD load flowing into the Huatanay River was reduced by 3.4 times compared to the BOD load registered before the Project[33]. Accordingly, it is deemed that the Project was far more effective than planned concerning reduction in the discharge of pollutant substances into the Huatanay River.

Meanwhile, concerning sewage treatment, there are issues such as the high BOD concentration and excessive volume of inflowing sewage. The BOD concentration of inflowing sewage was 445 mg/liter in 2015, higher than the planned level of 400 mg/liter. Moreover, high concentrations of industrial wastewater, oil, sand, clay, etc. mixed with the sewage caused equipment of the plant to become damaged quickly. The collector network in Cusco is basically separated from the drainage network. However, in reality a lot of rainwater enters the system and the sewage inflow reaches 2,000 liter/sec. at times of rain.[34] Even when rain isn't falling, sewage inflow exceeds 802 liter/sec and it is discharged without undergoing treatment. It is thought that this is because the increase in population exceeded the forecast calculated when the Project was being planned.

Accordingly, regarding sewerage in Cusco, the anticipated Project effects on the reduction of pollutant discharged to the Huatanay River have been achieved more than planned, and the Project effectiveness is deemed to have been "very high".

（4） Sicuani water supply

In Sicuani, where there are numerous water sources that use spring water, the main issues were expansion of the water distribution network to newly constructed residential districts, and securing water pressure for distribution to districts at high altitude. At the time of the second field survey of ex-post evaluation, construction of the water supply facilities was almost completed, but the facilities were still not in operation. The following paragraphs

[33] Due to the influx of rainwater and discharge of highly concentrated, untreated sewage at times of heavy flow, the sewage collection rate and treatment rate couldn't be calculated. Accordingly, it is not clear what percentage of pollutants has been reduced.

[34] Construction of rainwater drainage is the responsibility of local governments, and local governments sometimes arbitrarily connect drainage channels to sewerage networks. In Cusco, at least 200 such connections have been confirmed. Moreover, in order to drain away the water that covers roads at times of rainfall, residents often remove sewerage manhole covers in order to let the rainwater flow in.

describe analysis of the results of water production tests implemented by Sicuani SSC (40 liters/sec), past achievements in terms of expanding the water distribution network, etc., and prospects for the realization of effects after facilities have gone into operation.

Concerning increase in water supply capacity, approximately 40 liter/sec, exceeding the planned level of 18 liter/sec was confirmed through trial production, making it possible to deal with future increases in the demand for water.[35] In the Project, expansion of the water distribution network was implemented in six districts as planned, and service population was increased from 25,000 in 1995 to 38,000 in 2012. Achievements in increase of service population by the Project were as planned. On the other hand, construction of the water supply network was unable to keep pace with expansion of the residential districts, so the water supply coverage rate fell slightly from 88% (1998) to 86% (2015).

The water pressure has been appropriate at around 15 meters water column on average (before completion of the Project). However, in districts that are situated at higher altitude than the existing water distribution reservoirs, the water pressure is inadequate and not enough water is reaching residents. When the water reservoirs in the Project go into operation, appropriate water pressure will be secured even in areas with higher altitude and the situation will be improved. Concerning the water supply time, thanks to the abundant water sources in this city, it was already at 23.8 hours (2012) and there was not much room for improvement.

The non-revenue water rate was improved from 57% (1995) to 44% (2015). It is thought that the Project partly contributed to this by renewing pipelines in city districts that previously experienced severe leaks. In future, if some 3,000 water meters are installed or replaced as planned separately from the expansion of distribution network, it will be possible to improve the non-revenue water rate even more[36].

Accordingly, the anticipated Project effects regarding water supply in Sicuani have been achieved almost as planned, and the Project effectiveness is deemed to have been “high”.

（５） Sicuani sewerage

Concerning sewerage in Sicuani, the main issues were expansion of the collector network in newly constructed residential districts, and the elimination of untreated sewage discharged to rivers. At the time of the second field visit of ex-post evaluation, construction of the sewerage network was almost completed, but the sewage treatment plant was still not finished, and both the network and the plant were still not in operation. The following paragraphs describe analysis of the past achievements in terms of expanding the sewerage network, etc., and prospects for the realization of effects after the sewage treatment plant and

[35] The arsenic concentration is high in some water sources, however, such increase of water production has been achieved using only water sources that have lesser arsenic problems.

[36] The Project goal concerning reduction of non-revenue water is unclear, and it is difficult to determine the extent of the Project contribution.

other facilities have gone into full operation.

The sewerage service population increased from 20,000 (1995) to 37,000 (2012). In the Project, it was planned to expand the collector network in seven districts, while expansion of collector network was implemented in eight districts. As a result, increase of the service population of sewerage network by the Project was larger compared to the plans.

The sewage treatment flow is expected to reach at 80 liter/sec, which is more than the planned level of 77 liter/sec. Moreover, because it is planned to treat all the collected sewerage, the Project is expected to greatly reduce discharge of untreated sewage to rivers. However, as the plant is not yet in operation, actual results are not known. Also, as is described in the section on sustainability, there are a few concerns over the operation and maintenance of the Sicuani sewage treatment plant. Therefore, at the time of ex-post evaluation, it is not possible to forecast operational results of the plant and judge the anticipated Project effects regarding sewerage component in Sicuani.

3.3.3 Summary

The effectiveness of the Project in each city can be summarized as shown in Table 6 based on the above analysis. Considering the weight of each component based on the planned costs, the overall project is deemed to have been high.

Table 6 Evaluation of Effectiveness

	Degree of achievement of target	Project cost ratio
Iquitos water supply	Very high	36%
Cusco water supply	High	9%
Cusco sewerage	Very high	35%
Sicuani water supply	High (expected)	4%
Sicuani sewerage	(not judged)	16%
Overall	High	100%

Note: As the actual cost of some components is unknown, planned values were used for the Project cost ratio.

3.4 Impacts

3.4.1 Intended Impacts

In the Project, it was anticipated that the construction of water supply and sewerage facilities would make a contribution towards improvement of environmental and sanitary conditions in the target districts. The following sections explain the results of the survey of beneficiaries in Iquitos and Cusco. As for Sicuani, no such analysis of impact was conducted as the project effects are yet to be materialized. Improvement of water quality of the Huatanay River which was the main target for environmental improvement in Cusco is analyzed.

Table 7　Main Results of the Beneficiary Survey

	Iquitos	Cusco
Source of water (multiple responses)		
SSC	99%	99%
Refined water (bottled)	59%	37%
Recycling of laundry water	6%	44%
Rainwater	6%	44%
Sources of potable water (multiple responses)		
SSC	66%	100%
Refined water (bottled)	60%	37%
Water supply hours	4.1 hours	19.5 hours
Households that answered they have problems with water supply		
Poor water quality	81%	37%
Short and irregular water supply times	79%	12%
High tariffs	39%	44%
Low water pressure	34%	19%
Frequent water supply interruptions (1 day or more)	25%	20%
Poor maintenance	13%	18%
Poor customer service	17%	13%
Degree of satisfaction with water supply services		
Very satisfied	4%	5%
Satisfied	29%	38%
Slightly satisfied	21%	27%
Slightly dissatisfied	35%	23%
Very dissatisfied	21%	7%
Change in the water supply service (general) following Project implementation		
Greatly improved	0%	11%
Slightly improved	20%	24%
No change	21%	50%
Slightly worse	43%	12%
Much worse	16%	2%

	Iquitos	Cusco
Degree of improvement in water supply service following Project implementation*		
Water quality	3%	0%
Water supply time	-8%	8%
Water cuts	8%	10%
Water pressure	-1%	-7%
Tariffs	-6%	-55%
Maintenance	2%	-36%
Customer service	3%	-29%
Households that answered they have problems with sewerage		
Sewage overflows	-	17%
Bad odor	-	13%
Degree of satisfaction with sewerage services		
Very satisfied	-	10%
Satisfied	-	58%
Slightly satisfied	-	17%
Slightly dissatisfied	-	11%
Very dissatisfied	-	3%
Degree of improvement in household sanitation*	64%	66%
Degree of improvement in local area sanitation*	12%	36%
Changes in lifestyle		
Change for the better	72%	46%
Change for the worse	61%	29%
Change in frequency of diarrhea		
Increased	18%	4%
Decreased	29%	11%

Source: Beneficiary Survey
Note: For the "Degree of improvement", the ratio of responses saying that conditions had worsened was deducted from the ratio saying that conditions had improved.

（1） Results of the survey of beneficiaries (Iquitos, Cusco)

In the ex-post evaluation, as the survey of beneficiaries, questionnaire survey was conducted with respect to a total of 252 households in Iquitos and Cusco. The main results are shown in Table 7.[37] In addition, group interviews with residents were conducted two times in

[37] In Sicuani, no survey was implemented because the Project has not been completed and there were no target residents. The survey of beneficiaries, targeting 126 households in two districts of Iquitos and 126 households in three districts of Cusco, was implemented based on personal interviews using questionnaires. In order to select the households for interviews, first, representative districts in each city that are directly and indirectly benefited from this Project were selected. Then, sample households in each district were picked up in a random manner by visiting every fifth housing unit along the research routes in the blocks that were randomly determined on the map. 63 households in one district within Iquitos were those not having water supply service by the SSC prior to the Project, and the rest were households that had the service even before the Project.

each of Iquitos and Cusco.

Iquitos

In Iquitos, the survey was conducted during the dry season, when water production volume is low, raw water has high chromaticity, and it also coincided with the timing of repairs of the water treatment plant. As a result, many expressed high level of dissatisfaction with water quality and water supply hours, and more than half of the respondents expressed dissatisfaction with general water supply services. According to the survey of beneficiaries concerning the water supply service in Iquitos, residents are unhappy about numerous points including short and uneven water supply hours and poor water quality (turbidity, color), and only 33% of residents answer that they are very satisfied or satisfied with the water supply service. Although the low water quality may be a temporal phenomenon at the time of the survey due to the high chromaticity of the raw water and the repair work at the water treatment plant, its influence was big as 60% of households were separately purchasing potable water.

On the other hand, upon asking about changes following Project implementation to the 63 households that were using the SSC services from before implementation of the Project, only 20% responded that services improved, while more than half said that services deteriorated. Concerning water supply hours and tariffs, most respondents said that the situation had become worse. In some areas around the water treatment plants, even though water supply was available for 24 hours a day before the Project, the water supply hours per day decreased as a result of the Project due to the introduction of uniform water distribution in line with the construction of water distribution reservoirs in the Project. It is thought that this fact was reflected in the above responses.

Out of the targets of the survey of beneficiaries in Iquitos, 65 households (52% of total households) newly acquired water supply service thanks to the Project. These households previously used mainly well water (83%), refined water (49%) and rainwater (37%), while many of them responded that they could save on labor, time and cost in obtaining water and they could obtain high quality water thanks to the Project.

Generally speaking, many respondents indicated that their household sanitary situation had been improved (improved 70%, deteriorated 6%). The reason mentioned is easier access to water than before. Many respondents indicated that the frequency of diarrhea decreased (18% increased, 29% declined). Looking only at those households that had newly acquired water supply services, 43% of them responded that frequency of diarrhea had declined, with the two-thirds saying that the reason for this was the improvement in water. On the other hand, there were no reports of major improvement in the local sanitary conditions (improved 49%, deteriorated 37%). The possible reasons are that some districts become inundated at times of flooding, and that the sewerage system has not been sufficiently constructed. On the other hand,

70% of respondents said that the Project had imparted positive changes on lifestyle (mainly hygiene), but at the same time 60% said that there had been a negative change (mainly issues of sewerage).

Summing up, in Iquitos, although the Project is believed to have contributed to improvement of environmental hygiene conditions, there is deemed to be further room for improvement due to restrictions on effective water volume and sewerage improvement and expansion.

Cusco

The general degree of satisfaction with water supply services in Cusco is relatively high. 43% of households were satisfied with the water supply service. Around 30% of respondents voiced dissatisfaction, with half of those pointing to the high level of tariffs. In addition, dissatisfaction was also voiced on short water supply hours in districts at high altitudes. Some people indicated dissatisfaction with the water quality. According to Cusco SSC, it is thought that this has been caused by the construction works on water distribution pipes that are implemented throughout the city, as no problems have been confirmed regarding water quality at the water treatment plant. Many households responded that water supply services improved following implementation of the Project. Many households reported improvement to water supply time and reduction of water supply interruptions, while many people said that the situation had deteriorated in terms of tariffs, maintenance and customer service. Concerning sewerage, between 70-80% of households are satisfied with conditions. However, there have also been some reports of overflowing sewage and bad odor (details are explained in 3. 4. 2. (1)). It should be also noted that hardly any of the residents in the survey knew that sewage was being treated in the Project treatment plant.

70% of the respondents indicated that their household sanitary situation had been improved, and almost none responded that the situation had worsened. As the main reason for this, the respondents pointed to greater accessibility to water. Many respondents said that the frequency of diarrhea had declined. There were also numerous reports of improvement in the local sanitary conditions (improved 53%, deteriorated 17%). 46% of the respondents said that the Project had imparted beneficial changes on lifestyle (mainly hygiene), but at the same time 29% said that there had been a negative change (mainly issues of tariffs).

Summing up, in Cusco, it is deemed that the Project contributed to improvement of environmental hygiene conditions as planned.

（２） Improvement of water quality in the Huatanay River

Cusco’s Huatanay River, which was suffering from critical water pollution, was still receiving a lot of untreated sewage at the time of the ex-post evaluation. In particular, Safi River,

which is a covered conduit that runs through the historical district of Cusco and converges with the Huatanay River in the city, has a BOD concentration of approximately 300 mg/liter which is the equivalent of sewage. This is a major source of pollution in the Huatanay River. According to water quality data of past years, there was no clear indication that the Project resulted in less pollution in terms of BOD concentration and coliform group. The BOD concentration in the Huatanay River is 10 times higher than the environmental standard of 15 mg/liter, and the coliform group level is 1,000 times the environmental standard. Therefore, pollution in the river continues to be critical.

The Project sewage treatment plant is removing more pollutants than planned and is thus making contribution towards improving water pollution in the Huatanay River. However, the river water quality does not improve because of growth in the population and the increased sewage flow in Cusco and its surrounding area, slow progress in construction of the collector network[38], and continuing inflow of a lot of untreated sewage to the Huatanay River. Also, because rainwater is mixed in with sewage, the sewage flow exceeds the plant's treatment capacity and this is another reason for the discharge of sewage that is conveyed to the treatment plant but remains untreated[39].

3.4.2 Other Positive and Negative Impacts

（1） Environmental and Social Impacts

In each city, environmental impact assessment was conducted in accordance with legislation in Peru. In each case, no major environmental impacts were predicted, and the necessary measures were taken to mitigate and prevent any minor impacts of the works. The following paragraphs describe noteworthy environmental and social impacts in each city.

Iquitos

Following completion of the Project, no noteworthy environmental impacts have been reported. The construction sites of the water distribution reservoirs were all constructed on public land, and agreements were reached with the local government and university that owned the land. There was no need to relocate residents or pay compensation, and no social problems arose.

[38] In the Project, Huatanay collector (sewerage main) was constructed parallel to the Huatanay River based on Peruvian funding. Maximum pipe diameter when the Project was planned was estimated to be 1,200 millimeters, however, due to financial limitations, the maximum constructed diameter was just 600 millimeters. As a result, the sewage collection capacity is insufficient. Therefore, it is now planned to construct another new parallel sewerage main.

[39] In response to these issues, in August 2015, the Ministry of Housing, Construction and Sanitation reached agreement with Cusco SSC, Cusco Region and five related municipalities on formation of an investment program aimed at improving water quality in the Huatanay River. Based on multiple investment schemes, this program aims to construct rainwater drainage facilities, expand the collector network, expand the sewage treatment plants and so on, and concrete plans were being formulated at the time of the ex-post evaluation. In this program, the idea of additional treatment facilities on the site of the Project sewage treatment plant is being considered.

Cusco

In Cusco, it was planned to construct the sewage treatment plant in the downstream of the Huatanay River. However, it was too difficult to acquire the necessary land because there were so many landowners. Accordingly, the new treatment plant was constructed on the site of the existing sewage treatment plant, and there was no need to acquire new land.

In the sewage treatment plant, as a result of introducing the digestion tank, the quantity of sludge for final disposal was reduced and energy efficiency was improved by utilizing the digestion gas (methane gas generated through the digestion process). However, because sludge is not well digested (methane fermentation) as planned and held in the thickening tanks and storage tanks for a long time, it putrefies and generates gas with strong odor of hydrogen sulfide, etc. The residents living around the treatment plant have complained to the local government about the odor, and the local government has consequently pressed charges against Cusco SSC. While making an externally commissioned investigation on the cause of the odor and adjusting plant operation[40], the SSC is examining emergency countermeasures to prevent bad odor. The flammable gas that is generated in the digestion tanks is only used for heating sludge to facilitate the digestion process, while the remainder is incinerated.

In Peru, sludge from sewage treatment plant is regarded as a hazardous waste, and it cannot be received at a general final disposal site unless consent is given by the local government that manages the site. In Cusco, since no such consent has been given, there is a shortage of sites for disposing of dewatered sludge. For this reason, up until September 2015, it was necessary to discharge some of the sludge into the river at night, and this was imparting a negative impact on the environment. Cusco SSC is promoting the composting of digested sludge and tie-ups with waste disposal companies in the private sector, and it appears that all sludge will be appropriately disposed.

Sicuani

Approximately 4.2 hectares of land was acquired to construct the sewage treatment plant. Compensation of 1,580,000 Sol (approximately 55 million yen) was paid. There was no resettlement of residents. 4-5 years after the initiation of the sewage treatment plant operation, it will be necessary to remove settled sludge from the bottom of the anaerobic lagoons, dry it and finally dispose it. At the time of the ex-post evaluation, the location and method for final disposal of sludge were still not decided.

[40] Because operation of the sewage treatment plant in Cusco had been outsourced, Cusco SSC was unable to directly address this issue during this period. Since the SSC took over direct operation of the plant in January 2016, it has started efforts such as regulating retention time in the sludge thickening tanks.

（２） Other impacts

None in particular

As a summary, while the sewage treatment plant in Cusco has some issues concerning odor prevention, the Project contributed to improvement of the sanitary environment in Iquitos and Cusco and alleviation of water quality worsening in the Huatanay River in Cusco, and it mostly achieved its intended impacts in these two cities. Attainment of impacts in Sicuani is not judged. Based on the above, the Project has largely achieved its objectives. Therefore, effectiveness and impact of the Project are high.

Trial composting of sludge by Cusco SSC (left)

Repair team of water supply network of Iquitos SSC (right)

３.５ Sustainability (Rating: ②)

３.５.１ Institutional Aspects of Operation and Maintenance

Iquitos SSC has 365 employees in total including 18 engineers. The operating department conducts the operation and maintenance of water treatment plants and water distribution facilities. This department has 112 employees and there is no shortage of human resources.

Cusco SSC has 226 employees in total including 25 engineers. Its operating department conducts operation and maintenance of water treatment plants and sewage treatment plants. This department has 127 employees including more than 20 engineers, and there is no shortage of human resources. The sewerage treatment plant has 17 staff members including six technicians. A private sector operator used to conduct operation and maintenance. However, the outsourced operation and maintenance work did not fully reflect the requests of SSC and the operator did not provide reliable operation data. Therefore, the SSC employed several external engineers (sanitary expert, SCADA expert, etc.) and commenced directly-managed operation and maintenance from January 15, 2016. Concerning water distribution facilities and sewage

collection facilities, the maintenance department conducts repairs in response to calls from customers. Additional staff are employed during the rainy season when numerous issues arise in the collector network. The maintenance department conducts preventive maintenance of electrical and mechanical equipment. According to this department, there are some constraints in terms of manpower and means of transportation in this regard.

Sicuani SSC has a total of 37 employees but there is no civil / sanitation engineer[41]. Seven of these conduct repairs of water supply and collector network as well as installation of new connections. However, because it is faced with insufficient manpower, equipment and funds, it plans to employ six additional preventive and predictive maintenance personnel in 2016. Concerning operation and maintenance of the sewage treatment plant, Sicuani SSC needs to employ 15 more personnel including one engineer. It is necessary to secure human resources by the end of the construction works and start of trial operation. However, as is described later, there are problems concerning the source of funds and mode of employment and it is not yet clear who will be employed and how.

Summing up, concerning sustainability in institutional aspects, the sewage treatment plant operation and maintenance setup in Sicuani is unclear and has some issues.

3.5.2 Technical Aspects of Operation and Maintenance

Although Iquitos SSC has an internal training system, according to the National Sanitation Services Supervisory (SUNASS), there are few technicians and engineers who are endowed with expertise, and it is necessary to strengthen the technical capacity for water production and operation and maintenance. While it should be noted that the water treatment plant has a preventive and predictive maintenance plan and implements work according to this within the approved budget.

According to SUNASS, Cusco SSC has high technical and operational capacities that are second to the SSC of Lima Metropolitan Area in Peru. Judging from how the necessary data was provided for the ex-post evaluation, there is a sufficient base of data for conducting operation and maintenance. Because the Cusco SSC conducts its own troubleshooting regarding sludge treatment in digestion tanks, it is deemed to possess high technical capacity. Moreover, recruitment of external engineers helps it to secure ample technical capability for operating the sewage treatment plant.

Sicuani SSC has no engineers in the civil engineering and sanitation fields. Although there are employees who have worked for a long time in the facilities and understand them well, their technical levels are not high. Engineers with appropriate capacity are needed in order to appropriately operate and maintain the sewage treatment plant. However, since it is difficult for Sicuani SSC to employ highly competent human resources with its low salary levels, it is

[41] Since Sicuani has no water treatment plant, no human resource is assigned for this purpose.

necessary to examine the source of funding and mode of employment[42].

Summing up, concerning technical sustainability, there are minor issues in Iquitos, and there is concern in Sicuani about whether or not there would be sufficient technical capacity to appropriately operate and maintain the sewage treatment plant.

3.5.3 Financial Aspects of Operation and Maintenance

Table 8 shows the financial conditions of the SSCs in the three target cities in the Project.

Table 8 Financial Status of SSCs in the Three Target Cities

(Unit: 1,000 Nuevos Soles)

	Iquitos SSC			Cusco SSC			Sicuani SSC		
	2012	2013	2014	2012	2013	2014	2012	2013	2014
Operating revenue	25,177	24,998	27,540	34,573	40,311	50,128	1,846	2,221	2,282
Water supply and sewerage tariff revenue	22,774	23,999	25,593	34,573	40,311	50,128	1,343	1,455	2,282
Other revenue	2,403	999	1,947	0	0	0	503	766	0
Operating costs	30,749	33,170	38,585	31,211	37,260	42,959	2,206	2,301	2,306
Cost of operations (a)	18,642	21,582	25,805	22,464	26,693	30,281	878	916	559
Retail expenses	6,660	6,346	7,373	3,262	4,181	5,871	175	160	481
Administration cost, etc.	5,447	5,242	5,407	5,485	6,386	6,807	1,153	1,225	1,266
Operating profit	-5,572	-8,172	-11,045	3,362	3,051	7,169	-360	-80	-24
Non-operating revenue	937	17,720	25,103	14,546	5,443	7,016	6	6	203
Non-operating cost	19	2,723	9,073	13,417	1,897	4,991	0	0	0
Tax	0	0	0	0	1,022	2,293	0	0	0
Ordinary profit	-4,654	6,825	4,985	4,491	5,575	6,901	-354	-74	179
Working Ratio (b)	92%	102%	112%	90%	64%	68%	92%	81%	79%
Operating profit ratio	-22%	-33%	-40%	10%	8%	14%	-20%	-4%	-1%
Current ratio (c)	215%	36%	39%	439%	620%	357%	1,041%	40,317%	62,578%
Debt ratio (d)	275%	245%	260%	45%	34%	23%	1%	343%	578%

Source: SSC of each city

Notes:

(a) This includes operation and maintenance cost and depreciation cost.
(b) Operation and maintenance cost/operating revenue
(c) Fluid assets/fluid liabilities
(d) Liabilities/capital

Iquitos SSC faces difficult financial conditions mainly for the following reasons: low water tariffs, high rate of non-revenue water including stolen water, higher water production costs due to hikes in power tariffs, etc., high personnel costs[43]. It recorded an operating deficit

[42] In order to employ engineers who are endowed with sufficient capacity to operate and maintain Sicuani's sewage treatment plant, it is necessary to pay salary that is equivalent to at least two times the salary of the president of Sicuani SSC. However, since it is not necessary to employ such an engineer on a full-time basis for the sewage treatment plant alone, it may also be possible to employ on a part-time basis an engineer who is resident in another city such as Cusco, which is 3 hours away from Sicuani.

[43] The last hike in water tariffs was in 2010, when they were raised by 11%, however, they have been kept at the same level since then. The company attempted to reduce its personnel with a view to improving its business in

each year between 2013-2015. Its operating profit ratio (including depreciation cost) in 2014 was minus 40%, and its current ratio and debt ratio were both poor at 39% and 260% respectively. Since 2010, it has fallen behind in repayments for the ODA Loan that was transferred to it, and the MVCS has been covering the repayments to JICA. In these circumstances, Iquitos SSC deemed that it could not autonomously rebuild its finances and applied for Transitional Support Scheme under the Basic Water Act. It aims to rebuild its business while receiving technical support from the Technical Organization of Administration of Sanitation Services (OTASS: *Organismo Técnico de la Administracion de los Servicios de Saneamiento*) and financial support from the MVCS.

The financial standing of Cusco SSC is generally good. Its operations were making profit and its operating margin was around 10% each year of 2012-2014. Its current ratio and debt ratio in 2014 were also good at 357% and 23% respectively. It also keeps up to date with its ODA Loan repayments. In 2015, though it continued to show a positive operating profit, because the exchange rate changed unfavorably for repaying the Project loan, which is based on a foreign currency, it incurred a large non-operating loss and appeared likely to record a negative current profit for the year. According to the SSC, both operating profit and ordinary profit were in surplus in the first quarter of 2016.

Sicuani SSC faces harsh financial conditions. It has continuously incurred an operating deficit every year since 2005. In 2014, thanks to a reduction in depreciation costs, it entered profits. Its current ratio is high but its debt ratio has reached 578%[44]. Because it is unable to repay the assigned ODA Loan, the MVCS has been covering the payments. The treatment plant operation and maintenance is estimated to cost roughly 700,000 Sol per year[45], which is equivalent to some one third of annual sales income of the SSC. More cost would be needed if operation and maintenance cost of the newly constructed pumping station for water supply and other facilities are included. In order to cover this, it would be necessary to raise tariffs by some 50% or more, however, this would be difficult to do at once. Considering that an opposition movement arose during the Project among residents who feared tariff hikes, it is doubtful whether such an increase can be made to tariffs[46]. For this reason, the SSC has made a request to the MVCS to help cover operation and maintenance costs for around five years so that it can gradually increase tariffs. MVCS is currently examining the request. However, the current institutional framework does not expect the Ministry to directly support the operation and maintenance costs of a SCC, and nothing specific has been decided so far.

2008, however, it did not succeed because of opposition from the labor union.

44 The high current ratio of the Sicuani SSC is caused by the fact that the fund of state and city governments that are irrelevant to the operation of the SSC was nominally allocated as the current assets of the SSC, and the fact that the amount of such monetary value was large.

45 See section 3.2.1 Outputs (3) Sicuani for information on the change of plans regarding the sewage treatment plant.

46 According to SUNASS, which is in the position of approving water supply and sewerage tariffs, since the operation and maintenance cost of the Project in Sicuani is too large to be covered by tariff hikes, it would be necessary for the central government or region subsidize them in some way or other.

Summing up, in terms of financial sustainability, Iquitos faces major issues and Sicuani has some concerns.

3.5.4 Current Status of Operation and Maintenance

Repairs of the filtration tanks and replacements of valves at the water treatment plant in Iquitos are being implemented gradually within the budget. Meanwhile, as was described in 3.2.1 Outputs, some of the panels in the flocculation tank in the water treatment plant are missing, and the filter basin instruments, generator control panel, SCADA system, etc. are still not in operative condition. The pumps in the intake facilities become damaged quickly because the river water contains a lot of sediment, and replacements tend to be slow. If such situations are left alone, there is a possibility that such situation will eventually generate a significant impact on water production and water quality. In view of the harsh financial situation faced by Iquitos SSC as described above, and the fact that eight years have passed since the completion of the treatment plant under the Project, the MVCS has started to investigate the feasibility of a project for rehabilitation and renewal of the water supply facility.

Sewage treatment efficiency in Cusco is sufficiently high. Operation and maintenance is appropriately conducted. However, as was described in 3.4.2 (1) Environmental and Social Impacts, there is a problem with the strong odor that is generated in the sludge treatment process. Because of damage to motors caused by harmonic current at the sewage treatment plant, a plan to introduce a harmonic current suppression device is being examined. In general, operation and maintenance in the water supply and sewerage network are implemented appropriately.

The water supply and sewerage network in Sicuani is operated and maintained appropriately and no major problems have been reported. The sewage treatment plant was put into trial operation after its completion in July 2016, while it was not yet completed at the time of the second field visit for the ex-post evaluation.

Table 9 Evaluation of Sustainability by Cities

	Sustainability	Project cost ratio
Iquitos	Low	36%
Cusco	High	44%
Sicuani	Low – Fair	20%
Overall	Fair	100%

Note: As the actual cost of some components is unknown, planned values were used for the Project cost ratio.

Summing up about sustainability, Iquitos has minor issues in terms of technology and problems in terms of finances and its sustainability is low. In Cusco, its sustainability is high as there are no problems in operation and maintenance of the Project. In Sicuani, its sustainability

is low – fair as there are institutional, technical and financial concerns regarding the sewage treatment plant. Overall, sustainability of the Project effects has been fair.

4. Conclusion, Recommendations and Lessons Learned

4.1 Conclusion

The Project was implemented in order to improve the water supply and sewerage coverage rate in the Peruvian regional cities of Iquitos (Loreto Region), Cusco and Sicuani (Cusco Region) by means of improving and constructing water supply and sewerage facilities as well as enhancing capacity for water production and sewerage treatment, thereby contributing to improvement of environmental and sanitary conditions in the target area. From the time of the ex-ante evaluation through to the ex-post evaluation, the water supply and sewerage sector remained an important issue for the Government of Peru. At the time of the ex-ante evaluation, needs for water supply and sewerage development in the three target cities were high, and the Project facilities are playing an important role at the time of the ex-post evaluation. Moreover, the Project was consistent with Japan's aid policies at the time of the ex-ante evaluation. Therefore, the relevance of the Project is high. Due to two changes of government and deterioration of the operating conditions by SSC in the target cities following signing of the loan agreement, construction works of the sewerage component in Cusco and the water supply and sewerage components in Sicuani were delayed by more than 10 years, and the Project period was three times longer than planned. Due to price inflation over this period and expansion of the water treatment plants and sewage treatment plants and so forth, the Project cost was roughly 80% greater than planned. Accordingly, the Project efficiency was low. In Iquitos and Cusco, the project has realized water production and sewage treatment capacity greater than planned while expansion of the water supply and sewerage networks has been constructed mostly as planned. Accordingly, the Project has contributed to improvement of environmental and sanitary conditions as planned in both these cities. In Cusco, there has been major improvement in the water supply and sewerage coverage rates and water supply time as well as in prevention of pollution in the Huatanay River. On the other hand, in Iquitos, where issues remain concerning non-revenue water and water shortage continues, no major improvement has been witnessed in water supply services. In Sicuani, water supply and sewerage facilities are not yet completed and had not started operating by the time of the ex-post evaluation. While the project effect is expected to be high in the water supply sector, judgment cannot be made concerning the sewerage sector where concerns exist over operation of the sewage treatment plant. Summing up, effectiveness and impact of the Project have been high. In Cusco, there are no problems concerning operation and maintenance, and sustainability is high. In Iquitos, sustainability is low, as there are some minor issues in technical aspect and concerns in financial aspects. In Sicuani, since concerns remain over the sewage treatment plant in terms of

institution, technology and finance, sustainability is low-fair. Overall, sustainability of the effects realized by the Project is fair.

In conclusion, the Project is evaluated to be partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations to Implementation Agencies

Iquitos SSC

- In order to improve water supply services by fully utilizing the water treatment plant and transmission and distribution facilities that were constructed by the Project, Iquitos SSC should work on securing water intake capacity that is not influenced by river water level, further reducing the non-revenue water rate through sectorization of water distribution, and renewing electrical and mechanical equipment at the treatment plant and distribution reservoirs that have either broken down or reached the end of their lives.
- Iquitos SSC should make use of the Transitional Support Scheme and receive technical assistance from the Technical Organization of Administration of Sanitation Services and financial assistance by the government with a view to immediately consolidate management.

Cusco SSC

- Concerning the foul odor generated in the sludge treatment processes at the sewage treatment plant, Cusco SSC should investigate the cause and urgently examine measures and necessary adjustment of operation and maintenance procedure in order to resolve the problem.
- Cusco SSC should secure means for final disposal of sludge through tying-up with private enterprises and composting.
- Cusco SSC should work to prevent pollution of the Huatanay River through a public investment program in collaboration with MVCS and other local authorities.

Sicuani SSC

- Sicuani SSC should strive to complete the trial operation of the Project and quickly start the operation of facilities.
- It is necessary to secure the funding and human resources for operation and maintenance of the sewage treatment plant by the start of its operation. Since it is difficult to cover the necessary costs through water supply and sewerage tariff

hikes alone, and essential to receive financial assistance from the central government and others, it is necessary to immediately find a realistic solution in consultation with MVCS. Concerning the securing of engineers, it should also examine receiving support from the SSCs in Lima and Cusco.

Ministry of Housing, Construction and Sanitation (MVCS)

- MVCS should examine the technical support and financial assistance that are required by each SSC in order for them to implement the above recommendations. In particular, immediate assistance is required for Sicuani SSC because operation of the sewage treatment plant is about to begin.

4.2.2 Recommendations to JICA

JICA should liaise with and follow up MVCS and each SSC to make sure to implement the above recommendations. Particularly concerning Sicuani, in addition to monitoring activities with a view to realizing the early operation of the Project facilities, it should examine the feasibility of technical support including technical cooperation tied to ODA Loans and dispatch of senior volunteers concerning the operation and maintenance of the sewage treatment plant.

4.3 Lessons Learned

Re-examination of feasibility of delayed projects

In projects where there is a long interval between implementation of the feasibility study that was subject to the ex-ante evaluation and its actual implementation, changes may arise in external conditions such as the necessity of the project, land acquisition and operation and maintenance capacity of the implementing agency, making it necessary to make major changes in the original plan. In such cases, since there is a risk that the basis of decisions at the time of the ex-ante evaluation may be lost, it is necessary to review the background and process of such changes and re-examine the feasibility of the project, including analysis of multiple alternatives if necessary.

In the Project, the treatment technology at Sicuani sewage treatment plant had to be changed because it was not possible to secure the originally scheduled site area. As a result, doubts remained over its sustainability because the resulting change made it necessary to adopt more sophisticated technology and incurred more operation and maintenance costs. Concerning this change of plan, it was necessary to have more thorough examination with a study including review of alternative sites along with analysis of financial sustainability.

Monitoring of works outside the scope of the ODA Loan

As for contracts that use ODA Loan funds, JICA's consent is required in each stage of procurement (tender documents and tender evaluation), signing contracts and contract amendments, and JICA is able to scrutinize the contents and provide advice based on technical review where necessary. However, under the current JICA systems, such consent procedure is not required for contracts that are outside the scope of ODA Loans. Accordingly, it is possible to modify contracts and decide final scope of contracts without detailed knowledge of JICA, and inappropriate changes in plans that impact the project effects and sustainability could be made without any opportunity of appropriate advice by JICA.

In this Project, major changes were made to the plans for Sicuani sewage treatment plant. As the consulting service was funded by the ODA Loan, application for consent was submitted for the extension of consulting service for the abovementioned changes. However, the detailed information of these changes to the sewage treatment plant was not informed to JICA. If construction of the sewage treatment plant had been funded by the ODA Loan, it is possible that JICA could have grasped the details of the changes, conducted technical review and offered appropriate advice. Meanwhile, in Cusco, the water supply facilities and sewage collection facilities were removed from the targets of the ODA Loan. However, JICA was unable to appropriately follow the implementation situation in this case and this became a constraint in the ex-post evaluation.

Accordingly, concerning the contracts under ODA Loan projects that are not funded by the ODA Loan but are included in the scope of the projects, JICA should do more than just scrutinize the progress reports that are submitted by the implementing agency; rather it should strive to confirm the issues in implementation and feasibility to generate project effects upon seeking additional information, conducting on-site inspections and implementing sufficient monitoring. Moreover, in cases where important changes are made to plans within the scope of the project, even if such changes are outside the scope of the ODA Loan, JICA should demand that the implementing agency provide detailed information based on the obligation and rights written in the loan agreement.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual Achievement
①Project Outputs Iquitos water supply	・ Intake: reconditioning of intake 2 loc. ・ Water treatment plant: new construction (production capacity 520 liter/sec) ・ Water transmission pipeline: expansion and repair 18 kilometers ・ Clear water reservoirs: new construction 2 locations, repair 1 loc. ・ Pumping stations: new construction 1 location, repair 3 locations ・ Water distribution reservoirs: new construction 10 loc., repair 1 loc. ・ Distribution mains and distribution network:187 kilometers ・ Connections: new construction 11,388 (including meter installation), repair 3,594	・ Mostly as planned ・ New construction (production capacity: 750 liter/sec) ・ Expansion and repair 15 kilometers ・ New construction 3 locations, rehabilitation 1 location ・ As planned. ・ New construction 10 locations, repair1 location ・ 135 kilometers ・ New 11,084, repairs 1,348, meter installations 11,388 ・ Introduction of SCADA system (added)
Cusco water supply Transmission and distribution facility	・ Water distribution reservoirs: new construction 4 locations ・ Pumping stations: new construction and reconstruction 3 locations ・ Water transmission and distribution pipeline: (transmission) new construction 26 kilometers, (distribution) new construction 16 districts, 29 kilometers ・ Connections: new construction 3,564 (including meters)	・ New construction 1 location ・ New construction and reconstruction 2 locations ・ Partially implemented, 9 kilometers out of 26 kilometers, not implemented 8 kilometers; concerning the remaining 9 kilometers, the planned locations and implementation situation are unclear ・ New 3,564 or more
Cusco sewerage Collection facility Treatment facility	・ Sewerage main:15 kilometers ・ Secondary collector:16 kilometers ・ Collector network:16 districts, 23 kilometers ・ Connections: new construction 7,190 ・ Treatment plant:300 liter/sec, oxidation pond system ・ Conveyance pipeline to the new plant:7 kilometers	・ 13 kilometers ・ 14 kilometers ・ 15 districts, extension unclear ・ Unclear ・ 460 liter/sec, trickling filter system ・ None
Sicuani water supply Water projection facility	・ Water intake and conduction facilities: rehabilitation (2 loc., springs) ・ Water distribution reservoirs: new construction 2 loc., rehabilitation 2 loc. ・ Pumping stations: new construction 2 loc. ・ Chlorine injection system (2 locations) ・ Water transmission pipeline and	・ Rehabilitation (3 locations, springs) ・ New construction 2 locations, rehabilitation 2 locations ・ New construction 2 locations ・ 1 location ・ Combined with the water

	distribution mains:6 kilometers ・ Water distribution network: expansion 6 districts, 19 kilometers	distribution network 17 kilometers (plan when the contract was signed; actual situation unclear), expansion 6 districts
Sicuani sewerage		
Collection facility	・ Sewerage main and collector network:21 kilometers ・ Pumping stations:1 location ・ Connections:7 districts, new 2,125	・ 20 kilometers (to be decided) ・ 2 locations ・ 8 districts, number of new connections is unknown.
Treatment facility	・ Treatment plant:77 liter/sec, oxidation pond system	・ 80 liter/sec, anaerobic lagoon and trickling filter combined system
②Project Period	September, 2000 - May, 2005 (57 months)	September, 2000 - May, 2016 (not completed, 189 months)
③Project Cost		
ODA Loan	7,636 million yen	6,010 million yen
Fund by Peru	2,545 million yen	(Unknown)
Total	10,181 million yen	(Unknown)
(Total *)	8,554 million yen	15,216 million yen
Exchange Rate	1 US$ = 113.5 yen 1 Nuevo Sol = 34.0 yen	1 US$= 101.0 yen 1 Nuevo Sol = 32.7 - 38.4 yen

* The total amount remaining after removing the values for the water supply system and the sewer collection facilities of Cusco, where actual amounts spent are not known, from the total project expense.