Republic of Peru

FY 2016 Ex-Post Evaluation of Japanese ODA Loan Project

"Provincial Cities Water Supply and Sewerage System Improvement and Expansion Project"

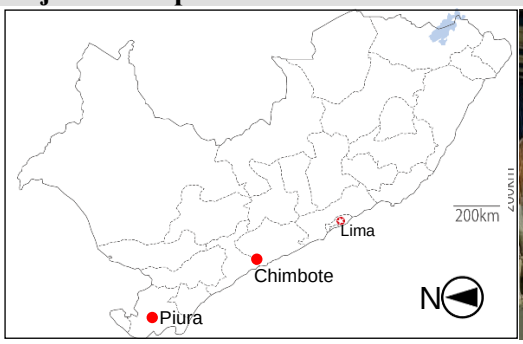
External Evaluator: Hajime Sonoda, Global Group 21 Japan, Inc.

0. Summary

The Provincial Cities Water Supply and Sewerage System Improvement and Expansion Project (hereinafter referred to as "the Project") was implemented in order to improve the water supply and sewerage services in the Northern Peruvian local cities of Piura (Piura Region) and Chimbote (Ancash Region) by means of rehabilitating and expanding water supply and sewerage facilities, thereby contributing to improvement of environmental sanitation in the target areas. Water supply and sewerage sector has consistently remained an important issue for the Government of Peru. At the time of appraisal of the Project, needs for water supply and sewerage development in the two target cities were high, and the Project facilities are still playing an important role at the time of the ex-post evaluation. Moreover, the Project is consistent with Japan's aid policies at the time of appraisal. Therefore, the relevance of the Project is high. Due to changes in government twice and worsening of the financial conditions of Sanitation Service Companies (hereinafter referred to as "SSCs") in the target cities after the signing of the loan agreement, commencement of the construction was delayed. In the case of the San Martin Sewage Treatment Plant (hereinafter referred to as "STP") in Piura, a change of the original plan to respond to the demand increase took a long time to finalize and this plant is not yet completed by the time of the ex-post evaluation. As a result, the project period more than quadrupled compared to the planned period. The total project cost exceeds the planned cost because of price inflation, an increase of the construction cost in this extended period and other reasons. Therefore, the efficiency of the Project is low. The Project has increased the water production volume and improved the water supply hours and water pressure in both cities and has also improved the water quality in Piura. Untreated sewage is no longer discharged to the river or the sea in Piura city and southern part of Chimbote. Improvement of the environmental and sanitation conditions are reported by residents in both cities. However, the water production volume by the water treatment plants (hereinafter referred to as "WTPs") has not reached the relevant planned level. In addition, the treated sewage does not meet the quality standards for treated waste water, partly because the volume of sewage received by the STPs far exceeds the planned volume. Therefore, the effectiveness and impact of the Project are fair. In regard to the operation and maintenance of the Project, the organizational aspects show minor problems in both cities, the financial aspects are problems in both cities and the technical aspects show problems in Chimbote. Based on the overall judgement of the above, the sustainability of the Project is fair.

In conclusion, the Project is evaluated as unsatisfactory.

1. Project Description



Project locations

Water Treatment Plant in Piura

1.1 Background

In Peru, when the economy collapsed in the late 1980s, hardly any investment was carried out in the water supply and sewerage sector, and deterioration of the facilities continued unchecked. Against the background of constant population inflow to urban areas, the water supply coverage rate decreased, the water supply capacity was unable to keep up with demand, and restrictions were placed on water supply hours in many local cities. The sewerage coverage rate was even lower than the water supply coverage rate with almost half of all local cities having no STPs and untreated sewage being discharged into rivers.

The administration of President Fujimori (1990 - 2000) considered water supply and sewerage improvement to be an important policy issue and conducted reform of the sanitation sector in 1992. As a result of this reform, a new system was established whereby regional governments provide water supply and sewerage services through SSCs with technical support under the National Program for Potable Water and Sewerage and supervision by the National Superintendence of Sanitation Services.[1]

In 1992, the National Program for Potable Water and Sewerage formulated the National Water and Sewage Program and the work began to improve water supply and sewerage services with the assistance of JICA and other donors.[2] For local cities, a series of feasibility studies on water supply and sewerage improvement projects were completed by 1995 with the assistance of the Inter-American Development Bank targeting multiple regional cities, including the two target cities of the Project.

Against the background described above, water supply and sewerage improvement work was

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[1] The National Program for Potable Water and Sewerage (PRONAP: Programa Nacional de Agua Potable y Alcantarillado), the National Superintendence of Sanitation Services (SUNASS: Superintendencia Nacional de Servicios de Saneamiento). Following the restructuring of government organizations, the work of PRONAP was inherited by the National Program for Urban Sanitation (PNSU/MVCS: Programa Nacional de Saneamiento Urbano/Ministerio de Vivienda, Construcción y Saneamiento).

[2] JICA provided loans for the "Lima-Callao Metropolitan Area Water Supply and Sewerage Improvement Project" (1996), "Southern Lima Metropolitan Sewerage Improvement Project" (1996) and "Pomacocha-Rio Blanco 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 the improvement of infrastructure in some of these cities.

implemented under the Project in two cities, i.e. Piura (Piura District and Castilla District) in the Piura Region and Chimbote (Chimbote District and Nuevo Chimbote District) in the Ancash Region among the cities targeted by the said feasibility studies.[3]

1.2 Project Outline

To improve water supply and sewerage services in the Northern Peruvian local cities of Piura of Piura Region and Chimbote of Ancash Region by means of rehabilitating and expanding water supply and sewerage facilities, thereby contributing to improvement of environmental sanitation in the target area.

Loan Approved Amount / Disbursed Amount	13,901 million yen / 12,742 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	April 1999
Terms and Conditions	Interest Rate: Main work: 1.7%, 0.75% Consulting service: 0.75% Repayment Period (Grace Period): Main work: 25 years (7 years) Consulting service: 40 years (10 years) Conditions for Procurement: Main work: general untied 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)
Final Disbursement Date	December 2011
Main Contractor	Construtora Norberto Odebrecht (Brazil)/ CBPO Engenharia Ltda. (Brazil), GYM S.A. (Peru), Ingeniería Andina Ina Bromco Cia. Ltda. (Columbia)/ Hidalgo & Hidalgo S.A.(Ecuador), Hidalgo & Hidalgo S.A. (Ecuador)/ Ingeniería Andina (Ecuador), Hidalgo & Hidalgo S.A. (Ecuador|)/ Construcción y Administración S.A. (Peru), Abengoa S.A. (Peru)/ Teyma Uruguay S.A. (Uruguay)
Main Consultant (Over 100 million yen)	NJS Co., Ltd.(Japan)/ Cardenas & Bautista S.C.R.L. (Peru), Nippon Koei Co., Ltd. (Japan)/ OIST (Peru)
Related Projects	Provincial Cities Water Supply and Sewerage System Improvement and Expansion Project (II) (ODA Loan, 2000)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan, Inc.)

[3] The City of Piura consists of Piura District and Castilla District and the City of Chimbote consists of Chimbote District and Nuevo Chimbote District. The administrative unit of these cities is "district" and there is no formal administrative unit equivalent to "city". In this report, however, both Piura and Chimbote are described as cities for convenience.

2.2 Duration of Evaluation Study

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

Duration of the Study: October 2016 - February 2018

Duration of the Field Survey: January 17 - February 9 and June 3 - 11, 2017

2.3 Constraints during the Evaluation Study

The feasibility study for the Project was conducted in 1995 and the project appraisal was conducted during in 1999. As nearly 20 years passed till the ex-post evaluation, collection of information on various examinations made at the time of appraisal was restricted. Accordingly, although the actual amount of sewage produced is substantially larger than the forecast in both cities, detailed analysis of the reasons for this could not be conducted during this ex-post evaluation because the feasibility study report by the executing agency could not be obtained in which the said forecast was made.

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

3.1 Relevance (Rating: ③[5])

3.1.1 Consistency with the Development Plan of Peru

As already described in 1.1 Background, the water supply and sewerage sector was an important policy issue at the time of appraisal (1999) and the Government of Peru was making efforts to improve the water supply and sewerage services in local cities. In subsequent years, the second presidency of Alan Garcia (2006 - 2011) greatly increased the amount of public investment in the water supply and sewerage sector under the slogan of "Water for All".[6] The government administration of Pedro Kuczynski (2016 -) who succeeded President Garcia considers the water and sanitation sector to be one of the highest priority sectors and has adopted the targets of a water supply coverage rate of 100%, 24 hour water supply and sewerage coverage rate of 100% in urban areas by 2021. To achieve these targets, the integration of SSCs is being promoted along with strengthening of the technical assistance by the Technical Organization for Sanitation Service Administration.[7]

The medium-term strategy (planning period: 2016 - 2021) for the water supply and sewerage sector prepared by MVCS in 2015 lists "increased access to high quality and sustainable water supply and sanitation services in urban and rural areas" as a strategic target, introducing plans for strengthening of the operational capacity of SSCs, participation of the private sector and measures to secure the sustainability of the services.

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4 A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory

5 ③: High, ②: Fair, ①: Low

6 According to data of MVCS, the ratio of public investment in the water supply and sewerage sector to the GNP was 0.1% or less until 2005, however, since 2009 it has been 0.6-0.8%.

7 Organismo Técnico de la Administración de los Servicios de Saneamiento (OTASS)

As such, the Project is highly relevant to the development policies of Peru at the time of both the ex-ante evaluation and ex-post evaluation.

3.1.2 Consistency with the Development Needs of Peru

As already described in "1.1 Background", many regional cities were in need of improvement of the water supply and sewerage systems at the time of appraisal (1999). In Piura (population of some 290,000 in 1999), one of the two target cities of the Project, groundwater from wells was the only source of water supply with such problems as a high level of salinity and high cost of water production, making the construction of water supply facilities which would use surface water as the supply source instead of groundwater necessary. Moreover, sewerage facilities were in need of improvement as they were not functioning properly. In Chimbote (population of some 280,000 in 1999), there was an urgent need for the development of the water supply and sewerage systems for its urban areas expanding southwards.[8] At the time of the ex-post evaluation, as described in "3.3 Effectiveness", the facilities improved or constructed under the Project in these cities are playing an important role in the provision of water supply and sewerage services, meaning that the importance of the Project has been sustained at the time of the ex-post evaluation.

However, the installed capacity (water production capacity and sewage treatment capacity) of the WTPs and STPs which were rehabilitated or constructed under the Project is smaller than the actual demand, except for the San Martin STP in Piura which is planned to be constructed with a larger scale than originally planned.[9] In regard to the WTPs, water demand exceeded the estimate made at the time of appraisal in both cities because of a higher population increase than the original forecast and lesser improvement of the non-revenue water rate than anticipated due to the delay of meter installation and chronic water theft.[10] Moreover, the scale of the WTPs was reduced as part of the change of the project scope which took place in 2003 against the background of fiscal austerity imposed by the Government of Peru.[11]

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[8] In southern Chimbote, the existing WTP uses an irrigation channel as the water source, while wells are used for water production in northern Chimbote. The 1999 population for each city is an estimate based on information obtained from the SSC for each city.

[9] Various reference materials collected for the ex-post evaluation suggest that the target year used to determine the plant scale was 2025 for the WTP in Piura and 2010 for the STP in Piura and the WTP and STPs in Chimbote from the beginning. However, no information was obtained to concretely verify the actual planning process. The situation of the plant capacities being below the actual demands appears to have already existed in 2010 for the WTP and STPs in Piura and the STPs in Chimbote based on data relating to the water demand forecast, water production volume, sewage treatment capacity, sewage reception volume, water quality after treatment, etc.

[10] As of 2016, the actual population increase is some 20% higher than the forecast made at the time of appraisal for the same year in both cities. Meanwhile, the meter coverage rate is slightly higher than 70% of the planned level and the non-revenue water rate is almost double than predicted. According to MVCS, water theft (illegal connection without payment) accounts for a fair proportion of the non-revenue water in both cities. Such a high level of water theft was not fully known at the time of project planning. As described in "3.3 Effectiveness", it can also be pointed out that the renewal of old distribution pipes by the Project might not have led to a sufficient reduction of water leakage. No information was found on how the Project was planned to contribute to the reduction of the non-revenue water rate.

[11] The review of the water demand forecast during the process of examining a possible change of the project scope re-examined such matters as the population, water supply coverage rate, meter installation rate, water consumption per capita and non-revenue water rate. In each city, the water consumption per capita was reduced from the original

In regard to the STPs, according to MVCS and the SSCs in Piura and Chimbote,[12] population increase beyond the forecast made at the time of appraisal led to an increase of the sewage arriving at each plant. In Piura, the volume of sewage has also increased as a result of the private exploitation of groundwater due to new residential development which was not assumed at the time of appraisal.

In summary, as the capacity of the WTPs and STPs rehabilitated or constructed under the Project is smaller than the actual demand, the development needs have not been fully met. However, the necessity for the Project is clear and the lower capacity than the demand does not mean that the Project is not relevant to the overall development needs.

3.1.3 Consistency with Japan's ODA Policy

In February 1998, prior to the ex-ante evaluation, the Japanese High-Level Mission on Economic Cooperation and the Government of Peru agreed that poverty reduction, assistance for the social sector, development of economic infrastructure and environmental conservation were priority agendas for future economic cooperation from the medium to long-term viewpoint. *The Country Assistance Program for Peru* (2000) formulated on the basis of this agreement says that "cooperation in basic human needs will continue to be promoted centering on the development of water supply and sewerage systems" under the agenda of poverty countermeasures. Therefore, the Project is relevant to Japan's ODA policies for Peru.

Based on the above, the Project is highly relevant to Peru's development plans and development needs as well as Japan's ODA policies. Therefore, its relevance is high.

3.2 Efficiency (Rating: ①)

3.2.1 Project Outputs

Water supply and sewerage facilities were improved in Piura and Chimbote under the Project. The planned and actual outputs of the Project are shown in Table 1. Many of the facilities constructed under the Project have either improved or expanded the existing water supply and sewerage facilities in each city. However, they are scattered in these cities and do not necessarily function in an integral manner. The implementation process and the changes made to the scope of the Project for each city are discussed next.[13]

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level, resulting in a lower water demand forecast. The concrete basis for this modification was not confirmed by the ex-post evaluation.

[12] The SSCs for Piura and Chimbote are EPS GRAU S.A. for the former and EPS SEDACHIMBOTE S.A. for the latter.

[13] All of the changes made to the original plan, which are described in the following sections, were agreed between MVCS, the executing agency and JICA prior to their implementation.

Table 1 Comparison of Planned and Actual Outputs

Planned (at the Time of Appraisal)		Actual
＜Piura water supply＞		
・ Intake	1,500 liters/sec	1,320 liters/sec
・ Construction of Curumuy WTP	880 liters/sec	600 liters/sec
・ Construction of transmission pipeline*	51.6 km	55.9 km
・ Construction/rehabilitation of distribution network**	59.4 km	40.9 km
・ Construction of distribution reservoirs	(5 sites) 10,350 m^3	(6 sites) 16,000 m^3
・ Rehabilitation of distribution reservoirs	0	(5 sites) 88,000 m^3
・ Rehabilitation of well pumps	10 sites	11 sites
・ Construction/rehabilitation of house connections**	11,760 households	6,000 households
・ Installation of water meters	22,500 units	21,636 units (+ 864 in reserve)
・ SCADA (treatment plant, distribution reservoirs and wells)		As planned
＜Piura sewerage＞		
・ El Indio STP*** (Oxidation pond system)	Rehabilitation: 6.0 ha Construction: 12.7 ha Total: 239 liters/sec	Rehabilitation: 6.0 ha Construction: 20.0 ha Total: 200 liters/sec
・ San Martin STP (Oxidation pond system)	Rehabilitation: 9.6 ha Construction: 11.9 ha Total: 241 liters/sec	New plant is constructed on premises of existing plant: 32.3 ha (planned) Total: 690 liters/sec (planned)
・ Construction of pressurized sewer pipeline	10 km	8.1 km
・ Construction of pumping stations	1 site	1 site
・ Rehabilitation of pumping stations	4 sites	12 sites
・ Rehabilitation of sewer network	26.7 km	36.1 km
＜ Chimbote water supply＞		
・ Construction of raw water reservoirs	70,000 m^3 x 2	None
・ Rehabilitation/expansion of WTP	500 liters/sec	550 liters/sec
・ Construction of transmission pipeline*	19.9 km	14.8 km
・ Construction/rehabilitation of distribution network**	77.6 km	69.3 km
・ Construction of distribution reservoirs	(5 sites) 14,850 m^3	(5 sites) 15,000 m^3
・ Construction/rehabilitation of house connections**	7,300 households	9,243 households
・ Installation of water meters	50,000 units	28,100 unites (+ 3,400 in reserve)
・ Rehabilitation of wells	(3 sites) 135 liters/sec	(3 sites) 135 liters/sec
・ Rehabilitation of raw water reservoirs	(3 sites) 70,000 m^3	None
・ Rehabilitation of distribution reservoirs	(8 sites) 20,800 m^3	(5 sites)
・ Pumping stations	2 for rehabilitation; 2 for construction	2 rehabilitated and 1 constructed
＜Chimbote sewerage＞		
・ Construction of pressurized sewer pipeline	3.9 km	1.4 km
・ Construction/rehabilitation of sewer network**	50.8 km	49.2 km
・ Rehabilitation of pumping station	1 site	1 site
・ Las Gaviotas STP (Oxidation pond system)	Expansion: 7.5 ha Rehabilitation: 12.0 ha Total: 155.3 liters/sec	Expansion: 8.6 ha Rehabilitation: 12.0 ha Total: 157 liters/sec
・ Centro Sur STP (Oxidation pond system)	Construction: 2.5 ha 22.8 liters/sec	Construction: 2.4 ha 17 liters/sec
・ House connection	New: 150 households Rehabilitation: 3,000 households	New: 3,569 households Rehabilitation: 2,856 households
< Consulting Service >		
Project supervision (detailed design/work management)		As planned
Additional study on the Chimbote sewerage system		As planned

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

Notes:

* Pipeline from the WTP to distribution reservoir.

** While the original plan distinguishes construction from rehabilitation, the planned construction work appears to have included the replacement of existing pipelines. As such, the distinction between the planned construction work and planned rehabilitation work is unclear. There is no clear way to exactly distinguish the actual construction output and actual rehabilitation output.

*** El Indio STP of the Project consists of two separate STPs, namely “El Indio STP” which was rehabilitated and “Cuevín STP” which was newly constructed. They are located at the same premise but have different service areas. For convenience, in this report, these two STPs are referred together as “El Indio STP”.

(1) Piura

In regard to the water supply in Piura, fiscal constraints faced by the Government of Peru led to re-examination of the project scope and the water production capacity of the WTP to be newly constructed was reduced by some 30% and corresponding changes of the planned pipeline network were made (2003). At the same time, rehabilitation of those distribution reservoirs which had deteriorated with age was added to the scope. At the actual construction stage, changes were made to locations of the pipelines as well as work volume to reflect the newly discovered site conditions, including the non-existence of those pipelines subject to rehabilitation at the assumed locations and different geological conditions from those assumed. According to the Piura SSC, the renewal of the distribution network was conducted while disconnecting the house connections from the old pipelines which were not removed. As old and new pipelines became connected through the pipes for illegal connections installed by residents without permissions, water continued to flow to some parts of the old pipelines. Furthermore, since wood plugs were used to shut off the house connections to the old pipes, there is concern on leakages of water flowing from the new pipeline at those locations where sealing was not sufficient.[14]

In regard to the sewerage in Piura, during the process of reducing the project scope mentioned above, the scale as well as the planned treatment level of STPs (planned water quality of treated sewage) was reduced while not changing the planned volume of sewage to be received. This change was judged not to cause any major problems as the range of crops benefitting from the treated sewage used for irrigation was limited. Of the two planned new STPs, the work to construct the San Martin STP was delayed because of failure to acquire part of the planned land after signing for the work. The subsequent discovery that the actual volume of sewage to be treated was much larger than the original forecast made it necessary to plan a larger facility. Because the revised plan could not be completed by the final disbursement date (December 2011) of the ODA loan at the time, it was decided in May 2011 that this plant would be constructed using MVCS's own funds (within the scope of the Project). As of June 2017, the procurement process is in progress for this plant. At the El Indio STP, the treated sewage is used for irrigation. The outlet channel from this completed plant was connected to an existing small irrigation channel which was actually too small to handle the volume of treated sewage from the plant, causing standing water around the plant. To rectify the situation, the Regional Government of Piura constructed a temporary irrigation channel (outside the project scope) in 2014.

(2) Chimbote

In regard to the water supply in Chimbote, scope of the Project was reduced against the

[14] According to the Piura SSC, having learned a lesson from this, the pipeline renewal project in recent years involves the removal of old pipelines in its scope although it results in an increase of the project cost. The same applies to Chimbote.

background of fiscal constraints faced by the Government of Peru as in the case of Piura. The actual changes included reduction of the plant size and cancellation of the construction/rehabilitation of raw water reservoirs. Because of further deterioration of existing pipelines, expansion of residential areas and fresh paving of roads in the period from the time of appraisal to the commencement of construction in 2005, and new findings during the construction on existing water supply network and geological conditions the work volumes for various facilities were modified to accommodate these changes. The original plan envisaged the construction of new water treatment facilities along with the rehabilitation of existing facilities on the same premises. Following the proposal by the contractor that the construction of a new mechanical flocculation basin while utilizing some of the existing facilities, such as the sedimentation basin and filtration basin, would reduce both the construction cost and operation and maintenance cost and also increase the water production capacity, the original plan was modified as proposed by MVCS with the consent of JICA. Although the Chimbote SSC had no previous experience of operating a mechanical flocculation basin, no technology transfer by means of either advance training or trial operation after completion was conducted. (Refer "3.5.2 Technical Aspects of Operation and Maintenance" for more details.) According to the Chimbote SSC, the position of the drain pipe of the treated water storage tank is too high to conduct complete water drainage for cleaning, etc., forcing the SSC to use a separate pump to drain the water. As in the case of Piura, the distribution network was renewed without removal of the old pipelines, leaving a possibility of water leakage from the points where sealing was not sufficient.

In regard to the sewerage in Chimbote, groundwater level was higher than assumed at the two STPs and the work to introduce impervious protection was added in order to prevent penetration of underground water to the treatment ponds. Number of new house connections was greatly increased due to added connections to new houses. While the original assumption was that treated sewage from the two plants would be used for irrigation, as in the case of Piura, the length of the outlet channel was some 30 m. At the Las Gaviotas STP where the existing plant was expanded, the outlet channel was connected to the irrigation channel constructed by farmers who had been already engaged in irrigated farming using the treated sewage. At the newly constructed Centro Sur STP, farmers constructed the connecting irrigation channel but the drainage from this channel was poor, causing spillage. To rectify the situation, the Chimbote SSC raised the outlet channel by approximately 50 cm in order that the treated water could be released farther away.

3.2.2 Project Inputs

3.2.2.1 Project Cost

Table 2 shows the planned and actual project cost. Compared to the planned total project cost of 18,535 million yen (ODA loan of 13,901 million yen), the actual cost at the time of the ex-post evaluation is 17,905 million yen (97% of the planned cost) with 12,743 million yen of the ODA

loan being used (92% of the planned amount). With the addition of 134 million nuevos soles (around 4,650 million yen, planned amount as of June 2017) funded by the Peruvian side for the planned construction of the San Martin STP, the final total project cost is 22,555 million yen (122% of the planned cost).

Table 2 Planned and Actual Project Cost

(Unit: million yen)

	Planned			Actual (As of June 2016)		
	Total	ODA Loan	Peruvian side	Total	ODA Loan	Peruvian side
Piura water supply	7,269	6,397	872	5,636	4,721	915
Piura sewerage	1,519	1,337	182	*2,690	2,345	*345
Chimbote water supply	2,327	2,048	279	3,259	2,322	937
Chimbote sewerage	1,019	896	123	1,478	1,219	259
Price escalation	922	735	187	0	0	0
Physical contingency	1,306	1,142	164	0	0	0
Consulting services	1,346	1,346	0	2,135	2,135	0
Tax	2,827	0	2,827	2,707	0	2,707
Total	18,535	13,901	4,634	*17,905	12,743	*5,162

Source: Materials provided by JICA and MVCS

Note: *These figures do not include the cost of San Martin STP (approx..4.3 billion yen) to be constructed by the Peruvian funding.

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 each contract term)

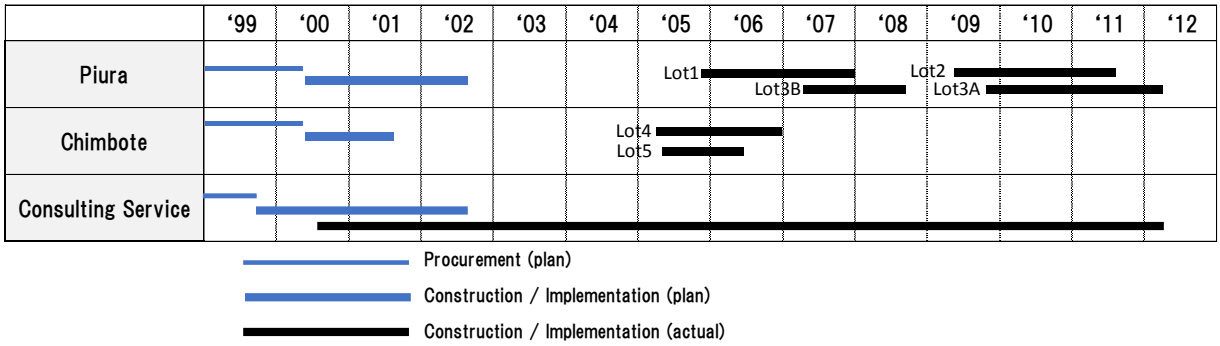
The reduction of the project scope with the fiscal constraints faced by the Government of Peru as its background was made in order to reduce the project cost. However, the US dollar-based total amount of the six contracts for the civil works for the water supply and sewerage components of the Project in the two cities (when the contracts were signed) already exceeded the relevant amounts planned at the time of appraisal by slightly more than 30%, because of the increased unit prices of materials, etc. as a result of price inflation since 1998. After the signing of these contracts, as explained in 3.2.1 Project Output, the amount of each contract was either increased or decreased because of the removal of the San Martin STP in Piura from the scope of the contract as well as ODA loan, increased construction volumes in both cities and other reasons. The actual cost of the consulting service substantially increased following the extension of the project period. Meanwhile, the average exchange rate during the period of the civil works from 2005 to 2011 was US$1 to 101 yen, signifying a massive appreciation of the yen from the planned US$1 to 140 yen at the time of appraisal. Because of the fact that the construction contracts were based on the US dollar or Peruvian nuevo sol, the strong yen reduced the yen-based project cost.

3.2.2.2 Project Period

The loan agreement for the Project was signed in April 1999 and the Project was scheduled

for completion in March 2003. The final loan disbursement date for the Project was extended twice[15], and six contracts subject for the ODA loan were completed by March 2012 (Fig. 1). These six contracts subject for the ODA loan under the Project are shown in Table 3. As of June 2017, the San Martin STP which was subsequently excluded from the scope of the ODA loan is undergoing the procurement process[16], meaning that the Project is not yet fully completed. The actual project period is 219 months as of June 2017 (April 1999 to June 2017), rising to 456% of the planned period of 48 months (April 1999 to March 2003). As nearly two more years are expected to be required until the completion of the San Martin STP, the actual project period will be considerably longer than planned.

Figure 1 Planned and Actual Project Period in Each City (ODA Loan Portion)



Source: Materials provided by JICA and MVCS

Major reasons for this considerable increase of the project period are listed below.

- After the signing of the loan agreement, reorganization of government ministries and downsizing of the executing agency occurred following the two changes of the administration. During the project period, financial situation of the SSCs in the two cities worsened because of political and economic confusions at the time, the austerity of government finance, decentralization policy implemented from 2002, and others.
- It took two years from 2002 to 2003 to narrow down the project scope reflecting the austere fiscal policy of the Government of Peru.
- After the commencement of the consulting services, it was discovered that the executing agency could not provide sufficient information to review and prepare the detailed design, resulting in the temporary suspension of the consulting service, based on the discussion between the executing agency and JICA, from 2001 to 2004 while maintaining the contract.

[15] The original final disbursement date was August 2004 but was extended to February 2009 which was further extended to November 2011.

[16] This plant is expected to require one and a half years to construct after signing of the construction contract. According to MVCS, the construction is in progress as of December 2017.

- In 2003, the failing business situation of the Piura SSC led to a proposal to introduce the concession method for part of the Project.[17] It took four years until 2006 to examine this proposal, delaying the commencement of the work for Lot 2 and Lot 3A.
- Some of the tenders had to be repeated because of such reasons as the absence of bidders within a predetermined price and the absence of bidders passing pre-qualification. The contract process for Lot 1, Lot 2 and Lot 3B took 2 - 5 years to conclude.
- Construction period for each contract was extended for up to six months because of the change of the scope of work, additional work due to unforeseen site conditions and delayed pump procurement (re-procurement / re-importation).
- The San Martin STP in Piura was originally included in Lot 3A as a subject for the ODA loan. However, it was put outside the scope of the ODA loan (within the project scope but to be funded by the Peruvian side) due to the necessity for the re-planning of this plant to make it bigger (2011). Following the subsequent re-planning and domestic appraisal procedures, construction of the plant is at the procurement stage as of June 2017.

Table 3 Construction Contracts for the Project (Those Covered by the ODA Loan)

Contract Lot	Description	Contract Date	Completion Date
Lot 1	WTP in Piura	November, 2005	December, 2007
Lot 2	Water Supply Network in Piura	May, 2009	July, 2011
Lot 3A	Water Supply and Sewer Networks in Piura	November, 2009	March, 2012
Lot 3B	STPs and Sewer Network in Piura	April, 2007	August, 2008
Lot 4	WTP and Water Supply Network in Chimbote	March, 2005	December, 2006
Lot 5	STPs and Sewer Network in Chimbote	April, 2005	June, 2006

Source: MVCS
Note: The San Martin STP in Piura is outside the scope of the ODA loan.

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

Internal rate of return was not calculated at the time of appraisal. Trial re-calculation of the financial internal rate of return (FIRR) is conducted for reference in this ex-post evaluation in connection with the construction of the intake, WTP, transmission pipelines and distribution reservoirs of the water supply component of the Project for Piura. This re-calculation uses a project life of 25 years, construction, operation and maintenance costs as costs, and revenue from the water supply service and saving of the water production cost from wells (electricity cost) as

[17] The agreed policy was for a private company with a concession to be responsible for the construction/rehabilitation of the water supply and sewer networks and also for the operation and maintenance of these networks along with the WTP and STPs after their construction. This concession method was later abandoned after further examination.

benefits, and the resulting FIRR is 10.3%.[18] No re-calculation is conducted for other components of the Project due to the lack of enough data.

As is described above, the project cost exceeded the planned cost while the project period significantly exceeded the planned period. Therefore, the efficiency of the Project is low.

3.3 Effectiveness [19] (Rating: ②)

3.3.1 Quantitative Effects (Operational and Effect Indicators)

While the purpose of the Project was to improve the water supply and sewerage services in Piura and Chimbote, indicators to measure the level of achievement of this purpose in each city were not clearly given at the time of appraisal. For the ex-post evaluation, therefore, the level of achievement of the purpose was determined mainly based on those indicators directly linked to the specific purposes of the Project in each city as primary indicators, which were identified among various indicators related to urban water supply and sewerage services, taking into consideration the development/improvement needs for the water supply and sewerage systems in each city confirmed at the time of appraisal.[20] Those indicators related to expected substantial contributions of the Project were also used as secondary indicators. Target values for individual indicators were decided based on the forecast water supply and demand and other data for each city which were referred to at the time of appraisal.

(1) Water Supply in Piura

Prior to the implementation of the Project, water supply in Piura relied entirely on groundwater from wells. Of the 25 wells, groundwater supplied by 23 wells contains salinity exceeding 250 mg/liter which was the standard value for drinking water set by the government. In some areas, water supply by direct pumping from a well was unstable due to the lack of distribution reservoirs. The Project planned target to make surface water account for 70% of the water production in 2015 by means of constructing a WTP (installed capacity: 880 liters/sec) using surface water from an irrigation channel as the water source and construction of distribution reservoirs in order to lower the salinity level to below the standard by means of appropriately mixing surface water and groundwater at the distribution reservoirs. Table 4 shows the relevant planned and actual achievement of the selected indicators.

Water production volume in Piura for the period from 2013 to 2016 was 1,225 liters/sec which

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[18] EIRR was not calculated because it was difficult to convert such benefits as savings on the water acquisition cost on the part of water users and improvement of public sanitation into monetary value.

[19] The effectiveness is rated in consideration of not only the effects but also the impacts.

[20] Level of achievement was judged according to the indications of JICA's Ex-post Evaluation Reference. As for those indicators with which comparison between planned and actual achievement is possible, if achievement of an indicator is "80% or higher" compared to the planned level, level of achievement is judged "high". If it is between "50 - 79%" or "49% or lower", it is judged "medium" and "low" respectively.

was equivalent to 136% of the planned figure at the time of appraisal. However, the WTP constructed under the Project produced water at a rate of 458 liters/sec in this period and this was only 73% of the planned level (630 liters/sec). The reason for this was the reduction of the production capacity from the planned 880 liters/sec to 600 liters/sec due to the budgetary austerity of the government coupled with production restrictions posed by insufficient transmission facilities and the water source.[21] To supplement the insufficient water production, water production from wells at a rate of 767 liters/sec from 2013 to 2016 was approximately 2.6 times the planned level of 300 liters/sec. It must be noted that the Project also contributed to water production from wells.[22]

Table 4 State of Achievement of the Water Supply Indicators in Piura

Indicators	Before the Project	Planned figures at the time of Appraisal (1998)	Actual Results	Level of Achievement
Water production volume	Unknown	900 liters/sec (2013 - 2016)	1,225 liters/sec (2013 - 2016)	High (principal indicator)
Ratio of surface water	0% Groundwater alone	70% WTP: 630 liters/sec Wells: 270 liters/sec (2013 - 2016)	37% WTP: 458 liters/sec Wells; 767 liters/sec (2013 - 2016)	Medium (principal indicator)
Ratio of households with lower level of salinity than the standard	Unknown	100% of households to which surface water is supplied	61% of households to which surface water is supplied (24% of total households) (2016)	Medium (principal indicator)
Water supply hours per day	Unknown	Unknown	17 hours/day (2016)	Medium* (secondary indicator)
Water pressure	Unknown	Unknown	11 mwc** (2016)	Medium (secondary indicator)
Meter coverage rate	9% (1995)	86% (2010)	59% (2016)	Medium (secondary indicator
Non-revenue water rate	55% (2002)	22% (2015)	51% (2015)	Low (secondary indicator

Source: Materials provided by JICA and Piura SSC.
Notes: * Achievement level compared to 24 hour/day supply which is the target of the Government at urban areas.
** The unit (mwc) for the average water pressure is "water meter column" the pressure capable of supporting one meter water column.

[21] According to the Piura SSC, there is no design leeway for the capacity of the transmission pipeline from the WTP to each distribution reservoir and of the water conveying pump at the plant. In addition to that, the volume of water transmission has been restricted by the changed hydraulic balance of the pipeline, which was caused by the relocation of one distribution reservoir to a far site because of the inappropriate geological conditions of the planned site and also because of the change of the production volume of groundwater to be mixed at each distribution reservoir. Although the Piura SSC has tried to adjust the operation, the maximum transmission volume is restricted to some 540 liters/sec. Moreover, the plant has to be shut down for approximately one week, three or four times a year, for maintenance of the irrigation channel.

[22] Eleven wells were either rehabilitated or expanded under the Project. Data for December 2016 shows that these wells account for some 20% of the total water production volume in Piura.

Water production of the WTP using surface water is 37% (2013 - 2016) of the total water production and is just above half of the planned rate of 70%. Water from the WTP is supplied to 39% of the total households in Piura. 34% of the households receive water from the plant which is mixed with groundwater at the seven distribution reservoirs constructed under the Project.[23] Because the salinity level is not sufficiently lowered after mixing at some of the reservoirs due to the low ratio of water from the plant, the salinity is lower than the standard at only 61% (24% of the total number of households) of those households receiving water supply from surface water (39% of the total number of households).[24]

The average water supply hours in Piura in 2016 were 17 hours/day with an average water pressure of 11 mwc (the standard pressure at the time of the ex-post evaluation is 15 - 50 mwc). According to the Piura SSC, the average water supply hours in the city prior to the Project were 8 - 10 hours/day and the Project made an important contribution to improvement of the water supply hours. The construction of six distribution reservoirs under the Project is considered to have contributed to steady water distribution in some areas.[25] However, some 43% of the water production volume in Piura is accounted for by directly supplied groundwater from wells without passing distribution reservoirs, meaning that water supply is unstable in nearly half of Piura. According to the result of the beneficiary survey, 51% and 37% of the households surveyed are not satisfied with the water pressure and water supply hours respectively.[26] In contrast, many positive opinions were expressed regarding the water quality and frequency of disruptions of water supply. In general, 64% of the households surveyed replied that the water supply service had improved after the Project.

Renewal of the distribution network and installation of water meters under the Project are believed to have contributed to reducing the non-revenue water. The Project renewed 7% of the entire distribution network (pipelines) and installed some 21,600 water meters which are equivalent to 22% of the total number of house connections. However, the possibility of the non-removal of old pipelines at the time of renewal leading to water leakage as described earlier can

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23 The remaining 6% of these households receive water from the plant without the mixing of groundwater.

24 Based on the assumption that some 10% of households receive low salinity groundwater among those solely receiving groundwater supply (61% of the total number of households), the ratio of households receiving the supply of water of which the salinity is below the standard in Piura is inferred to be 30%.

25 Number of new house connections in the service areas of the six distribution reservoirs constructed under the Project is equivalent to 23% of the total number of connections. Group interviews (the beneficiary survey) conducted in these areas found that the unstable water pressure under the previous direct conveyance from a well substantially improved after the completion of a distribution reservoir.

26 The beneficiary survey (questionnaire survey) was conducted with 102 households in Piura and 105 households in Chimbote. A total of nine group interviews with residents were held in the two cities. The questionnaire survey targeted those households connected to the water distribution network of the SSC even before the implementation of the Project in each city and used the two-step sampling method based on the distribution area and random area sampling within the distribution area. By gender, 29% of the respondents were male and 71% were female, and by age group, 18% were in their 20's, 20% in their 30's, 25% in their 40's and 36% in their 50's or older. The main results of this questionnaire survey are included at the end of this report. Group interviews were held four times in Piura and five times in Chimbote with particular care paid to avoiding any geographical bias. The participants of these interviews were those who had responded to an appeal by those cooperating with the Project at the selected sites (a total of 48 people at nine sites).

be pointed out (see 3.2.1- (1)). The meter installation rate increased to 82% in 2013 but then declined to 59% in 2016 because of the slow progress of the work to replace meters which service life (5 years) had elapsed. The non-revenue water rate (51% in 2015) did not reach the target (22% in 2015). According to the water leakage control section of the Piura SSC, rampant water theft is the cause of much non-revenue water.[27]

Based on the above, using the water production volume, ratio of surface water and the ratio of households with a lower salinity level than the standard as the principal indicators and other indicators as secondary indicators, the degree of target achievement of the Project in regard to the water supply in Piura is fair.

(2) Sewerage in Piura

At the time of appraisal, the limited sewage treatment capacity of 217 liters/sec (49% of the generated sewage volume) in Piura against the generated sewage volume of 444 liters/sec meant that half of the sewage generated in the city was discharged to the Piura River without being treated. The Project planned the reduction of the environmental load by the discharge of untreated sewage by means of increasing the sewage treatment capacity to 95% (484 liters/sec) of the generated sewage volume (508 liters/sec: year unknown) through the rehabilitation and expansion of two STPs. The planned treatment standard was assumed to be the quality level enabling the recycled use of the treated sewage for irrigation. Table 5 shows the state of achievement of the relevant indicators.

The effective treatment capacity (capacity of the operable sewage treatment facilities) of the two plants at the time of the ex-post evaluation is rather low at some 284 liters/sec (72% of the planned capacity), because the rehabilitation and expansion works (within the scope of the Project but outside the scope of the ODA loan) for the San Martin STP with a treatment capacity of 144 liters/sec has not yet started (see the section on efficiency) and a part (60 liters/sec) of the El Indio STP of which the treatment capacity was increased to 200 liters/sec under the Project is not yet in operation (see the section on sustainability).

[27] The Piura SSC adopts stringent water theft control measures with the assistance of the police as part of its non-revenue-water reduction program.

Table 5 State of Achievement of Sewerage Service Indicators in Piura

Indicator	Before the Project	Planned figures at Time of Appraisal (1998)	Actual Results (2014 - 2016)	Level of Achievement
Discharge of untreated sewage to the environment	Yes	Reduction	None	High (secondary indicator)
STP utilization rate (volume of sewage inflow / treatment capacity)	Unknown	Unknown	San Martin: 297% El Indio: 257% Total: 274%	Medium* (secondary indicator)
Quality of treated sewage	BOD: 20.0 mg/l SS: 50.0 mg/l Coliform: unknown	Wastewater standards (at the time of the ex-post evaluation) * BOD: 100 mg/l SS: 150 mg/l Coliform: 10,000 MPN/100ml	San Martin: BOD: 97mg/l SS:73mg/l Coliform: 2.4×10^6 MPN/100ml El Indio: BOD: 100 mg/l SS:96 mg/l Coliform: 1.8×10^5 MPN/100ml	Low (principal indicator)
BOD load removal volume (tons/day)	Unknown	San Martin: 5.1 El Indio: 5.1 Total: 10.2	San Martin: 6.8 (2016) El Indio: 8.3 (2016) Total: 15.1 (2016)	High (principal indicator)

Source: Materials provided by JICA and Piura SSC.

Notes: * As a STP operating rate substantially exceeding 100% is undesirable due to its problematic implication on treated sewage quality, the level of achievement is judged to be medium. For judgement of the quality of treated sewage, the relevant standard in Peru (maximum permitted level) at the time of the ex-post evaluation is used.

These two plants receive a combined total of 941 liters/sec of sewage (2014 - 2016) and have a combined utilization rate (volume of sewage inflow÷treatment capacity) of 274%, significantly exceeding the adequate level. The real utilization rate is even higher when the non-operating part mentioned above is taken into consideration. Such an excessive load is the direct reason why the quality of the treated sewage does not meet the national water quality standard for treated water to discharge. According to the Piura SSC, it is thought that the sewage volume has greatly increased beyond the planned forecast due to the expansion of the sewerage collection area in response to the expansion of urban areas, the increase of sewage generation due to the high rise in the housing, and inflow of non-domestic wastewater which was not envisaged. In the case of the San Martin STP, the existing plan envisages an increase of its treatment capacity to 690 liters/sec in the future and that it will receive part of the sewage currently received by the El Indio STP.[28] It should be noted that, in Piura, untreated sewage has not been discharged to a river since 2015, and the increase of the city's sewage treatment capacity under the Project has indirectly contributed to this.

[28] Once the construction of the San Martin STP has been completed along with the full operation of the El Indio STP, the combined utilization rate will be slightly more than 100% and the quality of the treated sewage is expected to improve.

The treatment of sewage at the two plants is insufficient due to over-loading[29] and the quality of treated sewage does not meet some of the relevant national standard for treated water discharged from a STP. Although the average BOD concentration of the treated sewage from 2014 to 2016 of 97 - 100 mg/liter is within the standard value of 100 mg/liter,[30] half of the measured values during this period exceeded the standard. Meanwhile, the coliform count (measured in September 2016) is as high as 10 - 240 times the standard.

The actual BOD removal rate (BOD concentration after treatment ÷ BOD concentration before treatment) at both of the STPs of 65% is low against the planned 99% at the time of appraisal. However, the actual volume of BOD removal (15.1 tons/day in 2016) is as high as 148% of the planned volume (10.2 tons/day) partly because the BOD concentration of untreated sewage (282 - 288 mg/liter) exceeds the planned concentration (250 mg/liter) at the time of appraisal and partly because the actual volume of the treated sewage is more than three times the planned volume.

In summary, although the environmental load of sewage is reduced more than planned (principal indicator: volume of removal of the BOD load), treatment at the plant is not adequate due to overloading, resulting in the discharge of treated sewage which does not meet the wastewater standards (principal indicator: quality of treated sewage). As such, the degree of achievement of the target for the sewerage service in Piura is judged to be fair.

(3) Water Supply in Chimbote

In Chimbote, an increase of water production capacity by means of expanding the existing WTP was planned to (i) improve the existing service with a water supply coverage rate of 71% (1996) and water supply hours of 2 - 14 hours/day and (ii) deal with an increasing population and expansion of urban areas.[31] The plan for the Project also included the construction of two new raw water reservoirs to better accommodate the maintenance period of the irrigation channel which was the source of water supply and the construction of distribution reservoirs to make water distribution more stable. Table 6 shows the state of achievement of the relevant indicators.

[29] At a STP using the oxidation pond system, such pollutants as BOD and coliforms are treated by the natural biological process during the retention of sewage in the pond (lagoon). The treatment of the sewage progresses with the passing of time, but a larger inflow volume renders this treatment less adequate because of the shorter retention time.

[30] Because of an insufficient number of measurement, average values for the measurement results of three years is used.

[31] The planned production capacity after expansion was 500 liters/sec.

Table 6 State of Achievement of the Water Supply Indicators in Chimbote

Indicator	Prior to the Project	Planned at Time of Appraisal (1998)	Actual Results	Level of Achievement
Water production volume (liters/sec)	Unknown	1,240 Plant: 500/750 (note) Wells: 213/463 (2015)	886 Plant: 373 Wells: 513 (2014 - 2016)	Medium (principal indicator)
Water supply hours per day	2 - 14 hours/day	Unknown	17 hours/day (2016) *	Medium** (secondary indicator)
Water pressure	Unknown	Unknown	18 mwc*** (2016)	High (secondary indicator)
Water supply coverage rate	71% (1996)	96% (2016)	89% (2016)	Medium (secondary indicator)
Meter coverage rate	5% (year unknown)	90% (2016)	66% (2016)	Medium (secondary indicator)
Non-revenue water rate	48% (year unknown)	22% (2016)	42% (2016)	Medium (secondary indicator)

Source: Materials provided by JICA and Chimbote SSC.

Notes: The water production capacity of the plant was planned to increase to 750 liters/sec in 2011. Although the planned water production volume was not shown separately for the plant and wells, it is likely that the planned water production capacity of the plant under the Project (500 liters/sec) was thought to be fully utilized in 2015.

* Average water supply hours per day further improved to 19 hours/day for 2017.

** Achievement level compared to 24 hour/day supply which is the target of the Government at urban areas.

*** The unit (mwc) for the average water pressure is "meter water column" which is the pressure capable of supporting one meter water column.

The water production volume in Chimbote from 2014 to 2016 was 886 liters/sec which is equivalent to 71% of the planned capacity at the time of appraisal. The WTP expanded under the Project has an installed capacity of 550 liters/sec but the actual production for the said period was 373 liters/sec which is equivalent to 68% of the installed capacity. The main reason for this was that the newly introduced mechanical flocculation basin was not fully functioning.[32] The cancelation of the planned rehabilitation and expansion of raw water reservoirs due to the reduced scope of the Project restricted the securing of raw water during the maintenance periods of the irrigation channel which was the source of raw water supply. Moreover, although three wells (combined production capacity of 135 liters/sec) were rehabilitated under the Project, none of these are functioning at the time of the ex-post evaluation due to breakdown of the pump and/or lowering of the groundwater level. According to the latest water demand forecast of the Chimbote SSC, water demand in Chimbote in 2016 was 1,116 liters/sec, meaning that the actual water production volume is hugely insufficient.

[32] According to the Chimbote SSC, the new mechanical flocculation basin requires the injection of more flocculant when the turbidity of the raw water is high. In such a case, economical operation is only possible by substantially reducing the production volume (flow rate). For this reason, the WTP in Chimbote continues to use the existing deteriorated non-mechanical flocculation basin while minimizing the use of the mechanical flocculation basin. The mechanical flocculation pond was not used for several years after its completion but has been used since 2015 with hardly any mechanical agitation and a flow rate of one-fifth of the design capacity. Because of this, the maximum combined production capacity of the two ponds at this plant is some 450 liters/sec even in a period when the turbidity of the raw water is low. According to MVCS, after the second visit of the evaluator in June 2017, the Chimbote SSC gave relevant training to the operating staff and the mechanical flocculation basin is being operated periodically at around 40% of the capacity in order to complement water production.

The five distribution reservoirs constructed under the Project (combined capacity accounting for 40% of the total capacity of the distribution reservoirs in Chimbote) are believed to have contributed to the improvement of the water supply hours as well as water pressure and the stabilization of water distribution operation together with an increase of the water production volume due to expansion of the WTP. To be more precise, the daily water supply hours of 2 - 14 hours prior to the Project improved to an average of 17 hours in 2016. The current average water pressure of 18 mwc is within the standard (15 - 50 mwc). Although the ratio of unsatisfied households is 28% in the case of the water pressure and 31% in the case of the water supply hours in the beneficiary survey, many respondents mentioned the post-project improvement of the water pressure, water quality and water supply hours. In general, 64% of the households replied that the water supply service had improved compared to 6% which said that the service had worsened. Another point to note is that the Project improved the water supply coverage rate by three points through some 3,000 new connections to the existing distribution network.

Renewal of the distribution network and installation of water meters under the Project are believed to have contributed to the reduction of the non-revenue water rate. Under the Project, 9% of the total distribution network (pipelines) was renewed and some 31,500 water meters equivalent to 35% of the total number of house connections were newly installed. As mentioned earlier (see 3.2.1- (1)), while, renewal of the distribution network without the removal of the old pipelines created a possibility of causing part of the ongoing water leakage. Water meter coverage rate increased to 66% in 2016 but this is below the target 90% adopted at the time of appraisal. Non-revenue water rate is estimated to be 42% (2015), failing to achieve the planned rate. According to the Chimbote SSC, water leakage accounts for half of the non-revenue water, while water theft is another major factor for non-revenue water.

Based on the above, the degree of target achievement of the Project in regard to the water supply service in Chimbote is judged to be fair using the water production volume as the primary indicator and other indicators as secondary indicators.

(4) Sewerage in Chimbote

At the time of appraisal, the limited sewage treatment capacity of 52 liters/sec in Chimbote against the generated sewage volume of 723 liters/sec meant that most of the sewage generated in the city was discharged to the sea without being treated. The Project planned (i) treatment of the entire sewage generated in southern Chimbote (Nuevo Chimbote District) by means of rehabilitation and expansion of the Las Gaviotas STP and construction of the Centro Sur STP to achieve a treatment capacity of 166 liters/sec and (ii) renewal of the deteriorated sewer network in northern Chimbote (Chimbote District). For the treatment of sewage generated in northern Chimbote, it was planned to conduct a supplementary survey on the submarine pipeline as part of the consulting service (an engineering service) of the Project with a view to incorporating the

survey findings in the sewerage improvement plan for northern Chimbote. Table 7 shows the state of achievement of the relevant indicators.

Table 7 State of Achievement of Sewerage Service Indicators in Chimbote

Indicator	Prior to the Project	Planned at Time of Appraisal (1998)	Actual Results (2014 - 2016)	Level of Achievement
Discharge of untreated sewage to the environment	Yes	Reduced in the southern Chimbote	Southern Chimbote: No Northern Chimbote: Yes	High (secondary indicator)
STP utilization rate (volume of received sewage/ treatment capacity)	Unknown	Unknown	Las Gaviotas: 159% Centro Sur: 294% Total: 172%	Medium(note) (secondary indicator)
Quality of treated sewage	BOD: 86.0 mg/l SS: 155.0 mg/l Coliform: unknown	Wastewater standards (at the time of the ex-post evaluation) (note) BOD: 100 mg/l SS: 150mg/l Coliform: 10,000 MPN/100ml	Las Gaviotas: BOD: 122mg/l SS:73mg/l Coliform: 1.1×10^4 MPN/100ml Centro Sur: BOD: 132 mg/l SS:152 mg/l Coliform: 1.7×10^6 MPN/100ml	Low (principal indicator)
BOD load removal volume (tons/day)	Unknown	Las Gaviotas: 2.6 Centro Sur: 0.3 Total: 2.9	Las Gaviotas: 3.4 (2016) Centro Sur: 1.3 (2016) Total: 4.7 (2016)	High (principal indicator)

Source: Materials provided by JICA and Chimbote SSC.
Note: As a STP operating rate substantially exceeding 100% is undesirable, the level of achievement is judged to be medium. For judgement of the quality of treated sewage, the relevant standard in Peru (maximum permitted level) at the time of the ex-post evaluation is used.

The two STPs rehabilitated and expanded under the Project achieved a combined treatment capacity of 174 liters/sec which slightly exceeded the planned capacity. As these plants receive a combined total of 300 liters/sec of sewage (2014 - 2016), the combined utilization rate is 172% which is the direct reason for the low treatment level at these plants. According to the Chimbote SSC, main reasons for the substantial increase of sewage volume above the planned level are the population increase exceeding the forecast made at the time of appraisal, the expansion of sewerage service area in response to the expansion of urban areas and increase in water production.

Since the completion of the Project, there has been no discharge of untreated sewage into a river in southern Chimbote. Through the increase of the sewage treatment capacity, the Project has contributed to this result. Sewage treatment in northern Chimbote is outside the scope of the Project. As there is no STP in northern Chimbote at the time of the ex-post evaluation, sewage collected in this area is discharged untreated to the sea.[33]

As in the case of Piura, sewage treatment operation at the two plants cannot be described as adequate due to huge over-loading. The average BOD concentration from 2014 to 2016 of 122 -

[33] As part of the engineering service for the Project, the detailed design was conducted for the sewage collection and treatment facilities and submarine pipeline in northern Chimbote. This design was not implemented because of the huge construction cost involved. At the time of the ex-post evaluation, it is planned to expand the Las Gaviotas Sewage Plant to receive and treat the entire sewage generated in both northern and southern Chimbote.

132 mg/liter exceeded the standard value of 100 mg/liter.[34] The number of coliforms at the Centro Sur STP is 170 times higher than the standard value. The actual BOD removal rate at the two plants is 55 - 73% which is much lower than the planned 80% at the time of appraisal[35]. However, the actual volume of BOD removal (4.7 tons/day in 2016) is as high as 164% of the planned volume (2.9 tons/day), partly because the BOD concentration of untreated sewage (296 mg/liter) exceeds the planned concentration (250 mg/liter) at the time of appraisal and partly because the actual volume of sewage is 1.7 times the planned volume.

In summary, although the environmental load of sewage has been reduced more than planned (principal indicators: volume of removal of the BOD load), treatment at the plants is not adequate due to over-loading, resulting in the discharge of treated sewage which does not meet the wastewater standards (principal indicator: quality of treated sewage). As such, the degree of achievement of the target for the sewerage service in Chimbote is judged to be fair.

(5) Summary

The degree of achievement of the target based on the above analysis is fair for both the water supply service component and sewerage service component in both cities. Therefore, the effectiveness of the Project is fair.

The process for demand forecast and scope modification of the Project

The actual water demand exceeded the demand forecast estimated at the time of appraisal (1998). The new water demand forecast at the time of project scope modification to reduce the project cost was a downward revision from the forecast adjusted at the time of appraisal, resulting in further underestimation of the future demand and the reduced scale of the WTPs lowered the effectiveness of the water supply service component of the Project. At the STPs, the treatment level declined due to the inflow of a much higher volume of sewage than the treatment capacity. It can be said that at the time of appraisal, the forecast of the sewage inflow was too low, but at the time of scope modification for the STPs (2003), there was no increase of the treatment capacity based on the new forecast on sewage generation. Treatment capacities of the STP in Piura and STP and WTP in Chimbote were planned under the Project to meet the water demand up to 2010. At the time of the project scope modification in 2003, it could be predicted that these facilities would be operating at full capacity several years after their completion. Nevertheless, there was no examinations on new projects to expand these facilities after their completion. In the case of the San Martin STP of which the initial plan was changed

[34] Because of the insufficient amount of measured data, the mean value for the measurement results of three years is used.

[35] According to MVCS, a maintenance program for Las Gaviotas STP has been started in 2017, and judging from the color of the water, the quality of the treated sewage might have been improved as of December 2017.

to increase its treatment capacity in anticipation of a demand increase, the construction work has been delayed and it is now expected that this plant will be operating at full capacity immediately after its completion.

The forecasts referred at the time of appraisal were made in the feasibility studies initiated by the Peruvian side. As no records are available concerning the examination results of the appropriateness of the demand forecast method and preconditions, it is not clear whether JICA has conducted sufficient technical analysis on the demand forecast made at the time of appraisal. When the project scope was modified in 2002 - 2003 following the Peruvian proposal, technical analysis took place at JICA's head office. While it is not clear whether the studies by Peruvian side had been conducted properly, information gathering was conducted through JICA Peru Office and analysis of the proposal was made on the basis of a series of Peruvian replies to JICA's questions regarding the contents of the proposal document. This examination mainly focused on the water demand forecast. JICA did not examine the forecast volume of sewage arriving at the treatment plants as no change of the original plan was proposed. No confirmation of concrete plans for the period after 2010 were made either.

Sewerage pumping station (Piura)

El Indio STP (Piura)

Distribution Reservoir (Chimbote)

Centro Sur STP (Chimbote)

3.4 Impacts

3.4.1 Intended Impacts

The Project was expected to contribute to improvement of environmental and sanitation conditions of the target areas through the development and improvement of water supply and sewerage facilities. Development of the relevant impacts in the two cities is described next with reference to the findings of the beneficiary survey.

According to the beneficiary survey in Piura, many of the respondents mentioned that the sanitation at home had improved (improved: 63%; worsened: 0%). The main reasons for this are easier access to water, improved hygienic practices, adequate treatment of sewage and waste and improvement of the quality of drinking water.[36] Many mentioned that frequency of bouts of diarrhea had decreased (decreased: 43%; increased: 4%). A similar tendency is observed with the hygiene environment in the nearby area, while a few replied that the situation had worsened (improved: 57%; worsened: 17%). In Piura, rainwater drainage facilities are not sufficiently available. Local flooding occurs at the time of rain. Rainwater flowing into the sewer pipelines occasionally damage the sewers and gushes out through the manholes. These phenomena are believed to be the causes of the negative response.[37] Nearly half of the households mentioned such desirable changes from the viewpoint of daily life as improved sanitation and increased convenience of water use (less labor and cost to obtain high quality drinking water,[38] change of the water quality making it suitable for cooking and washing). Only a small number of households mentioned undesirable changes.

Many of the respondents of the beneficiary survey in Chimbote found that household sanitation had improved (improved: 69%; worsened: 9%). Main reasons for the improvement are easier access to water, improved hygienic practices and improved quality of drinking water. Many of the respondents also said that frequency of bouts of diarrhea had decreased (decreased: 32%; increased: 2%). A similar trend is found with the hygiene environment in the neighboring area (improved: 65%; worsened: 6%). The local health authority indicated that the frequency of bouts of diarrhea among children decreased compared to 10 years ago. One-third of the surveyed households mentioned such desirable changes of daily life as improved sanitation and increased convenience of water use (less labor to fetch water). Only a small number of households mentioned undesirable changes.

In summary, improved environmental and sanitation conditions were mentioned by residents in both Piura and Chimbote and the improved water supply and sewerage services under the Project are believed to have contributed to such improved conditions. It should be also noted that improvement of the rainwater drainage facilities in Piura is necessary although the required work

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[36] Among these reasons, better hygienic practices and waste treatment were not featured in the Project.

[37] Rainwater drainage is not covered by the scope of the Project.

[38] Some of the respondents mentioned that, as local groundwater had a high salinity level, they used to travel 15 minutes from Piura to fetch water from a well in another town.

is not part of the responsibility of the Piura SSC.

3.4.2 Other Positive and Negative Impacts

(1) Environmental Impacts

For the implementation of the Project, an environmental impact assessment (EIA) was conducted for each construction contract and an environmental permit was then issued by MVCS. According to the Directorate General of Environmental Affairs of the MVCS, this permit was not required according to the legal framework related to the environment for project approval,[39] so the EIA was conducted between 2005 and 2009 in parallel with the detailed design prior to the commencement of the actual works based on each contract.[40] At the time, scope of the EIA and criteria for environmental permit were unclear, and hardly any monitoring was conducted based on the environmental impact mitigation plan which was prepared together with the detailed design.

In regard to the two cities' three STPs which were rehabilitated and expanded using ODA loan under the Project, treated sewage is recycled for irrigation. Quality of the treated sewage, however, does not meet the government's standard for wastewater from a STP. The crops using this treated sewage are reeds, fodder crops, maize and others. Although the treated sewage does not come into contact with the edible parts of these crops, there is concern in regard to contamination of the crops as well as groundwater in the case of the El Indio and Centro Sur STPs where the number of coliforms far exceeds the standard.

The outlet channel from each of these three plants is as short as some 30 m and is then connected to an earthen channel constructed by farmers (Centro Sur and Las Gaviotas STPs) or a temporary earthen channel built by the local government (El Indio STP).[41]

At the El Indio STP in Piura, the regional government constructed an extended section of the discharge channel. However, this is an open channel constructed with sandy soil and it frequently collapses, causing the spillage of the treated sewage. In view of the costly maintenance and environmental considerations, the Piura SSC has conducted improvement work to make the most problematic sections to be closed conduits. The Piura SSC plans to consult with irrigating farmers who use the treated sewage on the improvement of the irrigation channels and appropriate management of the treated sewage to find a solution while proceeding with the improvement of

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[39] At the time of appraisal, it was stated that "environmental impacts of the project are extremely small, and the executing agency has completed its own EIA even though there is no legal requirement for the implementation of an EIA". The details of the EIA mentioned here cannot be confirmed in the ex-post evaluation. The EIA mentioned in the main text means the EIA which was conducted by the executing agency for each work lot based on the legal system established later.

[40] The EIA for the San Martin STP which was to be constructed with the own funds of the Peruvian side was conducted in 2015.

[41] The current requirement for the implementation of a STP construction project in relation to the recycling of treated sewage for irrigation is that the irrigation users and plant management body exchange a written agreement that the treated sewage is properly managed through adequate connection of the outlet channel to the irrigation channel. At the time of appraisal of the Project, there was no such requirement and it was understood that even if the discharge channel was short, extension would be made by the farmers themselves who wanted to use the treated sewage for irrigation purposes.

the El Indio STP by preparing an environmental adjustment and management program.[42]

Extension of outlet channel for El Indio STP (Piura)

Irrigation channel connected to Centro Sur STP (Chimbote)

There is a private airfield near the Centro Sur STP in Chimbote. After the implementation of the Project, marshes were formed at the side of this airfield and water birds visiting these marshes began to disrupt airfield operation. According to the Chimbote SSC, the marshes are believed to have emerged due to a rise of the groundwater level. However, it cannot be denied that the discharged treated sewage from the Centro Sur STP may have also been a remote cause. Although this STP is over-loaded, further expansion is difficult because of its limited land. In view of these, the Chimbote SSC plans to close this STP and expand the Las Gaviotas STP so that the sewage currently sent to the Centro Sur STP will be diverted to the Las Gaviotas STP via a new pumping facility for treatment. At the Las Gaviotas STP in Chimbote, an outlet channel to the sea has been constructed with the government's own funding and the recycling of treated sewage is restricted to reeds, etc. Because of this, the partial excess of the quality standard for treated sewage at this STP does not pose any major environmental problems. In contrast, the continued practice of discharging untreated sewage from northern Chimbote causes concern in regard to seawater contamination. In this regard, the Chimbote SSC plans to expand the Las Gaviotas STP in the future so that it can treat the entire sewage from both southern and northern Chimbote.

(2) Land Acquisition and Resettlement

At the San Martin STP in Piura, the existence of private land on part of the planned site was

[42] An environmental adjustment and management program is equivalent to an EIA and includes a facility improvement plan for a STP to conduct proper treatment. Approval of this plan by MVCS is one condition for public investment in the STP concerned and also for permission for discharge of the treated sewage by the National Water Authority (SUNASS). In Chimbote, the environmental control improvement plans targeting the two STPs have been approved by MVCS. None of the four STPs targeted by the Project have obtained a discharge permit from the SUNASS at the time of the ex-post evaluation. However, this permit system has only been recently introduced and many STPs in Peru do have such a permit.

discovered after the commencement of the work, and this STP was removed from the scope of the construction contract for the ODA loan. Its construction at a new site with Peruvian funding is planned and the new site has already been secured. There were no problems regarding land acquisition for the other three STPs and new WTP in Piura. Land acquisition for the expansion of the WTP in Chimbote was unnecessary as this expansion took place on the premises of the existing WTP. No resettlement was required for the implementation of the Project.

(3) Other Impacts

In both cities, water production using surface water as the supply source to replace part of groundwater became possible with the implementation of the Project and the production cost was reduced.[43] In particular, the WTP in Piura is now capable of conducting low cost and efficient water production and has become a model for the design and operation of WTPs in Peru. This WTP is used for training organized by the Piura SSC and MVCS and receives frequent visits from university researchers and students.

Based on the above, this project has somewhat achieved its objectives. Therefore, its effectiveness and impact are fair.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional Aspects of Operation and Maintenance

As both SSCs in the two cities do not have sufficient manpower and equipment to properly conduct an emergency response or preventive maintenance, there are some problems relating to the institutional aspects as described below.

(1) Piura SSC

The Piura SSC provides water supply and sewerage services for 27 cities and towns in the Piura Region and has 786 employees. According to the SSC, its manpower size is generally adequate although it is insufficient to provide an emergency response in the rainy season, etc.

The WTP and transmission lines from the WTP to the distribution reservoirs are operated and maintained by 21 staff members, including five security guards. The WTP has a SCADA control room to coordinate water supply operation through telephone communication with the SSC's Piura Head Office and well or distribution reservoirs operators throughout the city. The El Indio STP has four operators and two security guards. No permanent operator is deployed at the San Martin STP due to insufficiency in personnel and bad security situations in the area. The water supply and sewer networks are repaired by 14 staff members and three outsourcing

[43] According to the SSC in each city, the unit water production cost at a WTP is one-fourth or one-fifth of the water production cost using a well.

contracts in response to claims made by residents. There is a preventive maintenance plan involving the use of a high-pressure cleaning vehicle and a bucket machine (pipe cleaning device) for the sewer system. According to the staff members in charge, however, cleaning operation is insufficient as limited personnel are busy dealing with emergency situations. Any repair of a large diameter sewer must be externally contracted when such work is necessary and takes time to complete. A total of 43 operators are deployed at wells and pumping stations. At the sewage pumping stations, removal of accumulated sludge and other work are outsourced. The SSC has a six-member maintenance team which is responsible for electrical and mechanical equipment in all of the 27 cities / towns where the SSC provides water and sewerage services. Repair work is conducted at a small workshop and is outsourced to a specialist company in Piura if necessary. According to the SSC, even though a preventive maintenance plan exists for electrical and mechanical equipment, it is hardly implemented because the team is too busy dealing with repair works.

(2) Chimbote SSC

The Chimbote SSC has 381 regular employees and 12 contract employees and operates water supply and sewerage services in southern Chimbote, northern Chimbote and two other cities.

The WTP is run by 13 operators on three shifts. During the first field survey, the position of the head of the WTP was vacant but a newly recruited young sanitation engineer has taken up the position since 2017. Of the two STPs, only the Centro Sur STP has one operator working during the daytime. Although no operator is deployed at the Las Gaviotas STP, the pumping stations which convey sewage to the Las Gaviotas STP have operators. The water supply network and sewer networks (pipelines) are directly maintained by 20 staff members in the case of the former and 10 staff members in the case of the latter. According to those in charge, the manpower level is inadequate to conduct a quick emergency response. The SSC possesses trucks, two high pressure cleaning vehicles, two bucket machines and other heavy machineries to deal with emergency situations requiring repair works for leakage or sewer blockage reported by residents. Although preventive maintenance of the sewer network is also conducted, the old bucket machines require renewal. Maintenance of electrical and mechanical equipment is conducted by one engineer and four workers. As the staff strength is insufficient, a request for assistance is frequently made to other sections. Minor repairs are conducted at the workshops on the premises of the SSC and major repairs are outsourced to a specialist company in the city.

3.5.2 Technical Aspects of Operation and Maintenance

(1) Piura SSC

The Piura SSC has 72 engineers. After the completion of the WTP by the Project, three engineers participated in JICA's training in Japan (JICA Group Training for Latin American

Countries).[44] All of them were appointed to senior positions on their return to Peru. According to these trainees, the training in Japan was a big incentive to improve the operation of the facilities of the SSC, especially the operation of the WTP, contributing to improvement of the technical level. Moreover, a system to inject an agent to contain the propagation of algae at the WTP was independently installed and the water treatment efficiency was increased through the adjustment of operation.[45] The new WTP is considered to be a model WTP and was the venue for technical training organized by the SUNASS in 2015 targeting 25 engineers of other SSCs in Peru. The Piura SSC built its own GIS in 2014 to accumulate customer as well as technical data. This system was built internally with the advice of engineers of other SSCs. At the time of the ex-post evaluation, training of two and a half years is in progress with German assistance for 23 staff members (operators) for them to obtain a qualification of technician relating to water production, water treatment and sewage collection. Based on the above, it is safe to assume that the technical standard of the Piura SSC is high.

(2) Chimbote SSC

Although the Chimbote SSC has several engineers, there is only one junior sanitation engineer who was newly recruited in 2017, and operation of the mechanical flocculation basin at the WTP is not appropriate.[46] Despite the fact that the SSC lacked any previous experience of operating a mechanical flocculation basin, the construction contract, including that for the WTP, did not include training nor trial operation period by the contractor. As far as the operation and maintenance of the WTP are concerned, a manual with only general contents was handed over and no training of the SSC staff members took place.[47] The dosage of the flocculant is based on an empirical value in correspondence with the daily measured raw water turbidity and flow rate but there is no regular jar test.[48] As such, the operation of the WTP by the Chimbote SSC is

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44 The Piura SSC sent one engineer in 2008 and three engineers in 2009 to JICA's training scheme in Japan entitled "Supplementary assistance to develop Japanese ODA Loan project's sustainability in the sanitation sector for Latin American Countries".

45 After its completion, the new WTP required frequent backwashing because of the massive propagation of algae and the water leakage rate [1 - (water production volume÷ water intake volume)] reached as high as 25%. The Piura SSC solved this problem without external assistance. The current water leakage rate is 3.7% compared to 10% assumed at the design stage.

46 See Footnote 32.

47 For the new flocculation basin, it is necessary to establish such parameters as the flocculent injection volume and agitation speed in response to the turbidity, pH value and treatment volume of raw water through test operation. However, the manual handed over to the SSC is only a general manual and does not refer to these parameters. According to a staff member involved in operation since the beginning, the contractor conducted test operation outside the scope of the contract (meaning unofficial test operation) for approximately one week but the operation did not reach the sufficient level of water treatment operation capacity. As such, actual operation commenced by staff members without an appropriate knowledge of the operation and maintenance of the WTP. According to MVCS, the contractor was required to deliver the facilities in proper functional conditions as stated in the contract and there was a one-year warranty after delivery. Because no claim that "the facilities did not function properly" was made to MVCS by the Chimbote SSC, MVCS did not take any special action.

48 The jar test determines the required injection volume of flocculant by means of injecting different volumes of flocculant to actual raw water and comparing the degree of flocculation of each injection volume. It is desirable to conduct this test on a daily basis. While the WTP in Piura conducts the jar test twice a day, the WTP in Chimbote

inadequate and there appears to be room for improvement of the technical level of this SSC. According to the SUNASS, in the background, a qualified engineer is not attracted to the SSC because of low salary level. On the other hand, in regard to sewer, as there are not facilities which require high level technology, no technical problems in operation and maintenance are identified.

3.5.3 Financial Aspects of Operation and Maintenance

Table 8 shows the financial conditions of the SSCs in the two target cities in the Project. As explained below, both SSCs have financial problems.

Table 8 Financial Status of SSCs in the Two Target Cities

(Unit: 1,000 nuevos soles)

	Piura SSC			Chimbote SSC		
	2013	2014	2015	2013	2014	2015
Operating revenue						
Water supply and sewerage tariff revenue (Including connection charge, etc.)	101,604	103,633	111,722	24,876	24,159	24,593
Operating costs	100,001	102,144	119,866	33,712	40,104	42,808
Cost of operations [(a)]	*70,624*	*71,276*	*84,657*	*22,800*	*27,772*	*29,039*
Retail expenses	*23,992*	*24,141*	*25,902*	*4,959*	*4,207*	*4,434*
Administration cost, etc.	*5,385*	*6,727*	*9,307*	*5,953*	*8,125*	*9,335*
Operating profit	1,603	1,489	-8,144	-8,836	-15,945	-18,215
Non-operating revenue	235	70	91	10,403	15,569	16,582
Non-operating cost	165	141	166	46	193	112
Ordinary profit	1,672	1,418	-8,219	1,521	-569	-1,745
Operating profit ratio	1.6%	1.4%	-7.3%	-35.5%	-66.0%	-74.1%
Current ratio [(b)]	127%	170%	125%	75%	107%	90%
Debt ratio [(c)]	891%	971%	1041%	944%	963%	921%

Source: SSC of each city

Notes:

(a) This includes the operation and maintenance cost and depreciation cost.

(b) Current assets/current liabilities

(c) Liabilities/capital

(1) Piura SSC

Both the operating profit and ordinary profit of the Piura SSC had been in the black up to 2014 but went into the red in 2015, partly because of writing off of the historical depreciation cost following the change of accounting standards to international accounting standards and partly because of the increased cost of operation due to an increased electricity charge. The SSC believes that the operating account in 2016 will return to the black. The current ratio exceeds 100% but is not sufficiently high enough, restricting the cash flow of the SSC. In fact, the maintenance of the STPs and sewage pumping stations is inadequate because of limited funds and manpower. When

has hardly conducted the test at all due to its manpower shortage and other reasons. According to MVCS, the Chimbote SSC intends to conduct jar tests more frequently to increase operational efficiency of the mechanical flocculation basin.

the financial health deteriorated in the early 2000's, the SSC deferred welfare payments for its staff members. These deferred payments are being paid out over a period of 30 years as a debt owed by the SSC to its staff members. Because of this payment, the debt ratio of the SSC is extremely high. Since 2017, the MVCS occupies the majority of the Board of Directors, and efforts to improve financial situations including debt treatment are continuing. According to the SSC, it is necessary to increase its service charges by some 60% in five years based on the revenue and expenditure plan for the future. As of June 2017, the SSC is in discussions with the SUNASS regarding the planned increase of the service charges.

(2) Chimbote SSC

The operating profit and ordinary profit of the Chimbote SSC have been in the red for the last three years in the case of the former and two years in the case of the latter. The service revenue accounts for only 60 - 70% of the operating cost and the operating profit ratio has been substantially negative. The revenue shortfall has been met by a subsidy from the regional government. The current ratio is often below 100%, restricting the cash flow. This means financial restrictions on maintenance. Because of the remaining debt service of a loan from the National Housing Fund (FONAVI) in the late 1990's, the debt ratio is extremely high, causing a problem for the medium to long-term financial health. The tariff was increased by 11% between 2008 and 2013 but the newly set charge did not take the maintenance cost of the raw water reservoir at the WTP and of the STPs, the renewal cost of water meters, etc. into consideration. The Chimbote SSC subsequently lodged a proposal for a 42% increase of the tariff in a five-year period from 2017 with the SUNASS taking the above-mentioned costs into consideration. Following appraisal by the SUNASS and other necessary procedures, including public meetings, an increase of 37% in a five-year period from May 2017 was approved.

Left: Cleaning works around the treatment pots (El Indio STP, Piura)
Right: Las Gaviotas STP (Chimbote)

3.5.4 Current Status of Operation and Maintenance

(1) Piura SSC

According to explanations given by the Piura SSC and the evaluator's own field survey findings, all water supply facilities ranging from the WTP, transmission pipelines, distribution reservoirs to wells and the distribution network are believed to be adequately operated and maintained. In regard to the sewerage facilities, however, some problems are found with the pumping stations and STPs.

According to the Piura Zone Office of the SSC, most of the city's 28 pumping stations for sewerage have electrical and mechanical problems. The pumps are damaged fairly quickly because of their full operational status, including reserve pumps, to deal with a large volume of sewage and also because of the much inclusion of sand and rubbish in the sewage.[49] An automatic operating system (system to control pumping operation in correspondence with the water level of collected sewage) and control panel frequently break down due to the adverse impact of voltage fluctuations. Because there are too many problems, repair work falls behind and there is no leeway to implement preventive maintenance. The fact that pumping operation can hardly afford to stop because of the large volume of sewage makes the implementation of preventive maintenance and repair work difficult.

At the El Indio STP, sludge and weeds floating on the surface are cleaned but deposited sludge in the treatment basins is not removed due to financial constraints. One of the ponds constructed under the Project at this STP has been divided by a dike constructed under a regional government project and is not in operation. This dike was introduced by the regional government for the purpose of installing an aeration system to increase treatment efficiency of the STP which had failed the wastewater quality standard due to over-loading. However, this project was suspended following a change of the regional government.[50] The water channel connected to the outlet channel of this STP was constructed by the regional government under the same project, but its temporary nature makes it prone to collapse. According to MVCS, the Piura SSC is conducting such regular maintenance works on the channel based on an annual plan as sludge extraction, weeding and slope strengthening.

(2) Chimbote SSC

Existence of sand deposits and vegetation at the raw water reservoirs of the WTP in

[49] According to the Piura SSC, this situation occurs when residents throw their rubbish and other foreign substance into sewers because they do not know how to properly use the sewer system. Moreover, residents sweep standing rainwater, including sand, on the road into the sewer system to improve drainage.

[50] The new regional government questioned the fact that the previous government implemented the project as "a maintenance project" despite it being an investment project, thereby bypassing the proper approval procedure for a public investment project. It then suspended the project and triggered a lawsuit against the previous government. During this lawsuit, the Piura SSC and regional government held a series of discussions to determine whether or not the dike could be removed but no conclusions have yet been reached. JICA has been monitoring these discussions but there is no prospect at present of the dike's removal.

Chimbote suggests a lack of maintenance for a long period of time. The work to remove these sand deposits using heavy machinery started in November 2016. Other than the mechanical flocculation basin, all of the facilities of this WTP are generally adequately operated and maintained.[51] However, some electrical and mechanical equipment has deteriorated after more than 10 years of operation since the completion of the WTP in 2006. The distribution reservoirs are subject to preventive maintenance, including cleaning and sterilization, and are generally adequately maintained. Of the 18 wells, including the three rehabilitated wells under the Project, some are out of order due to breakdown of the pump as pump repair or renewal has been slow due to budgetary constraints and many others are experiencing a decline of the production volume.

Floating sludge and sludge close to the edge of the treatment basins have been removed several times at the two STPs but the complete removal of sludge by emptying the basins has never taken place. At the Las Gaviotas STP, as the treatment basins rehabilitated under the Project did not originally have an impervious layer, lowering of the sewage level leads to the incursion of groundwater, making it impossible to completely drain the basins. (The treatment basins constructed under the Project have an impervious layer.) For this reason, the Chimbote SSC has prepared for the removal of sludge by a floating sludge pump and aims at commencing operation by the end of 2017.

To summarize on the sustainability of the Project, the institutional aspects show some minor problems in both cities, the financial aspects face challenges in both cities and the technical aspects show a problem in Chimbote. Based on the overall judgement of the above situations, the sustainability of the project effects is fair.

4. Conclusions, Recommendations and Lessons Learned

4.1 Conclusions

The Project was implemented in order to improve the water supply and sewerage services in the Northern Peruvian local cities of Piura (Piura Region) and Chimbote (Ancash Region) by means of rehabilitating and expanding water supply and sewerage facilities, thereby contributing to improvement of environmental sanitation in the target areas. Water supply and sewerage sector has consistently remained an important issue for the Government of Peru. At the time of appraisal of the Project, needs for water supply and sewerage development in the two target cities were high, and the Project facilities are still playing an important role at the time of the ex-post evaluation. Moreover, the Project is consistent with Japan's aid policies at the time of appraisal. Therefore, the relevance of the Project is high. Due to changes in government twice and worsening

[51] See Footnote 32 for the mechanical flocculation pond.

of the financial conditions of SSCs in the target cities after the signing of the loan agreement, commencement of the construction was delayed. In the case of the San Martin STP in Piura, a change of the original plan to respond to the demand increase took a long time to finalize and this plant is not yet completed by the time of the ex-post evaluation. As a result, the project period more than quadrupled compared to the planned period. The total project cost exceeds the planned cost because of price inflation, an increase of the construction cost in this extended period and other reasons. Therefore, the efficiency of the Project is low. The Project has increased the water production volume and improved the water supply hours and water pressure in both cities and has also improved the water quality in Piura. Untreated sewage is no longer discharged to the river or the sea in Piura city and southern part of Chimbote. Improvement of the environmental and sanitation conditions are reported by residents in both cities. However, the water production volume by the WTPs has not reached the relevant planned level. In addition, the treated sewage does not meet the quality standards for treated waste water, partly because the volume of sewage received by the STPs far exceeds the planned volume. Therefore, the effectiveness and impact of the Project are fair. In regard to the operation and maintenance of the Project, the organizational aspects show minor problems in both cities, the financial aspects are problems in both cities and the technical aspects show problems in Chimbote. Based on the overall judgement of the above, the sustainability of the Project is fair.

In conclusion, the Project is evaluated as unsatisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agencies

Piura SSC

- To secure a sufficient maintenance budget by adequately increasing the tariff for water and sewerage services.
- To increase water production volume by fully utilizing the water production capacity of the WTP through strengthening of the water transmission capacity based on the increased pumping capacity, etc. of the WTP.
- To implement preventive maintenance through outsourcing or other means along with the renewal and reinforcement of the sewage pumping facilities which have been experiencing a continued state of over-loading.
- To implement following measures at the El Indio STP;
    - Continuous negotiation with the regional government for an early removal of the dike constructed by the regional government.
    - Realization of proper maintenance of the oxidation ponds (removal of accumulated sludge), improvement of the outlet channel constructed by the regional government and adequate management of treated sewage with an agreement on the cooperation of

irrigation users by means of formulating and implementing an environmental management and adjustment program.

Chimbote SSC

- In relation with the mechanical flocculation basin, carry out the following activities by entrusting to those engineers with rich experience on mechanical flocculation basins; ① investigation of the causes of failure to achieve the design performance, ② training on establishment of parameters for adequate operation and operation and maintenance, and ③ renewal and improvement of equipment as necessary.
- To remove sludge at Las Gaviotas STP in accordance with the approved environmental management and adjustment program.

MVCS

- To urgently complete the rehabilitation and expansion of the San Martin STP in Piura.
- To examine the necessary technical and financial assistance for the purpose of ensuring the implementation of the recommendations listed above for the Piura and Chimbote SSCs.

4.2.2 Recommendations to JICA

JICA should conduct follow-up activities in liaison with MVCS and SSCs for ensured implementation of the above recommendations. It should also examine the possibility of providing technical assistance for the purpose of supporting the adequate operation of the WTP in Chimbote.

4.3 Lessons Learned

Adequate management of recycled treated sewage

When the recycling of treated sewage is planned in a sewage treatment project, full coordination with users of the recycled treated sewage is necessary so that the facilities and management system to adequately handle the treated sewage are in place. As for the recycling of treated sewage for irrigation, an existence of a management institution on the part of the irrigation farmers' organization and adequate connection between the outlet channel of the STP and irrigation channels are important. Adequate management of the treated sewage is essential to ensure the efficient use of the treated sewage and to avoid any environmental problems after the discharge of treated sewage from the STP. In this connection, it should be considered to carry out capacity development for farmers' organizations and repair or construction of irrigation channels as a part of those projects for recycling treated sewage for irrigation.

At the Centro Sur STP and El Indio STP rehabilitated / constructed under the Project, no capacity development for the users of the recycled treated sewage (farmers) was conducted

and the recycling of the treated sewage was left to farmers along with the construction / connection and operation of the irrigation channels. Because of this, the outlet channel of the STP was not connected to a suitable irrigation channels. In addition, as the volume of sewage for treatment exceeded the planned volume, there have been incidents of the spilling over of the treated sewage in the area near the STP. Examinations at the time of appraisal should have included the commitment of local farmers to the construction and adequate operation of the irrigation channels, existence of an irrigation plan and capacity of farmers' organization, and it could have been considered to include, as necessary, capacity building of farmers' organization and rehabilitation / construction of irrigation channels in the scope of the Project.

Need for an accurate demand forecast

In order to properly plan the facility size of a WTP (water production capacity) or a STP (sewage treatment capacity), an accurate demand forecast is required, necessitating use of an appropriate forecast calculation method as well as proper preconditions. Whenever a demand forecast is reviewed, efforts to further improve the accuracy of the demand forecast are necessary through a concrete examination of the latest data on population, water usage per capita, water saving effect by introduction of meters, water leakage reduction effect of renewal of deteriorated distribution pipes and other relevant matters. Even if it is necessary to reduce the project cost due to funding constraints, it is desirable for demand forecasting to be properly conducted, and immediate reduction of the project cost should preferably be achieved by bringing forward the original target year of the project (phasing of the project). When the adoption of such an option is difficult because of the implementation schedule, necessitating a reduction of the facility size, a plan to expand the facilities after the completion of the project should be swiftly prepared for implementation at the suitable time. In the case of this Project, as described in the article "the process of demand forecast and scope modification of the Project", it is unknown whether technical examinations of the forecast water demand as well as receiving volume of sewage were conducted at the time of appraisal and also at the time of changing the project scope. The significant departure from the forecast adversely affected the effectiveness and impacts of the Project.

Technical examination for the demand forecast review and application of comprehensive mid-term project management practices

When the scope of a project is changed from the feasibility study after a long period, a considerable change in the demand by that time is possible. It is, therefore, important for JICA to perform a technical examination for demand forecast review very carefully. In the Project, JICA headquarter conducted a technical examination on the proposal by the Peruvian side for a change of the scope, but this examination might not have been sufficient, partly because the

gathering of detailed information was not conducted in Peru (instead, replies to JICA's questionnaire on the Peruvian proposal were obtained on two or three separate timings).

Moreover, when extension of the final disbursement date is necessary because of a substantial delay of the commencement of construction works, JICA should examine the possibility of conducting detailed technical examinations comparable to those conducted at the time of appraisal. To determine whether such examinations are necessary or not, it may be an idea for JICA to conduct a comprehensive mid-term evaluation with a view to organize and record all the information gathered from the time of appraisal up to that point of the time of the said mid-term evaluation. In any case, it is important to appropriately organize and record the materials reviewed at each stage after appraisal.

Comparison of the Original and Actual Scope of the Project

Item	Planned	Actual
① Project Output		
＜Piura water supply＞		
・ Intake	1,500 liters/sec	1,320 liters/sec
・ Construction of Curumuy WTP	880 liters/sec	600 liters/sec
・ Construction of transmission pipeline*	51.6 km	55.9 km
・ Construction/rehabilitation of distribution network**	59.4 km	40.9 km
・ Construction of distribution reservoirs	(5 sites) 10,350 m^3	(6 sites) 16,000 m^3
・ Rehabilitation of distribution reservoirs	0	(5 sites) 88,000 m^3
・ Rehabilitation of well pumps	10 sites	11 sites
・ Construction/rehabilitation of house connections**	11,760 households	6,000 households
・ Installation of water meters	22,500 units	21,636 units (+ 864 in reserve)
・ SCADA (treatment plant, distribution reservoirs and wells)		As planned
＜Piura sewerage＞		
・ El Indio STP (Oxidation pond system)	Rehabilitation: 6.0 ha Construction: 12.7 ha Total: 239 liters/sec	Rehabilitation: 6.0 ha Construction: 20.0 ha Total: 200 liters/sec
・ San Martin STP (Oxidation pond system)	Rehabilitation: 9.6 ha Construction: 11.9 ha Total: 241 liters/sec	New plant is constructed on premises of existing plant: 32.3 ha (planned) Total: 690 liters/sec (planned)
・ Construction of pressurized sewer pipeline	10 km	8.1 km
・ Construction of pumping stations	1 site	1 site
・ Rehabilitation of pumping stations	4 sites	12 sites
・ Rehabilitation of sewer network	26.7 km	36.1 km
＜ Chimbote water supply＞		
・ Construction of raw water reservoirs	70,000 m^3 x 2	None
・ Rehabilitation/expansion of WTP	500 liters/sec	550 liters/sec
・ Construction of transmission pipeline*	19.9 km	14.8 km
・ Construction/rehabilitation of distribution network**	77.6 km	69.3 km
・ Construction of distribution reservoirs	(5 sites) 14,850 m^3	(5 sites) 15,000 m^3
・ Construction/rehabilitation of house connections**	7,300 households	9,243 households
・ Installation of water meters	50,000 units	28,100 unites (+ 3,400 in reserve)
・ Rehabilitation of wells	(3 sites) 135 liters/sec	(3 sites) 135 liters/sec
・ Rehabilitation of raw water reservoirs	(3 sites) 70,000 m^3	None
・ Rehabilitation of distribution reservoirs	(8 sites) 20,800 m^3	(5 sites)
・ Pumping stations	2 for rehabilitation; 2 for construction	2 rehabilitated and 1 constructed
＜Chimbote sewerage＞		
・ Construction of pressurized sewer pipeline	3.9 km	1.4 km
・ Construction/rehabilitation of sewer network**	50.8 km	49.2 km
・ Rehabilitation of pumping station	1 site	1 site
・ Las Gaviotas STP (Oxidation pond system)	Expansion: 7.5 ha Rehabilitation: 12.0 ha Total: 155.3 liters/sec	Expansion: 8.6 ha Rehabilitation: 12.0 ha Total: 157 liters/sec
・ Centro Sur STP (Oxidation pond system)	Construction: 2.5 ha 22.8 liters/sec	Construction: 2.4 ha 17 liters/sec
・ House connection	New: 150 households Rehabilitation: 3,000 households	New: 3,569 households Rehabilitation: 2,856 households
② Project Period	April 1999 - March 2003 (48months)	April 1999 - June 2017 (219 months, not completed yet)
③ Project Cost		
ODA Loan	13,901 million yen	12,743 million yen
Peruvian funding	4,634 million yen	5,162 million yen*
Total	18,535 million yen	17,905 million yen*
Exchange Rates	USD 1 = 113.5 yen 1 nuevo sol = 34.0 yen	USD 1 = 101.0 yen 1 nuevo sol = 32.7 - 38.4 yen

*These figures do not include the cost of San Martin STP (approx..4.3 billion yen) to be constructed by the Peruvian funding.

<Appendix> Main Findings of the Beneficiary Survey (Questionnaire Survey)

	Piura (102 Households)	Chimbote (105 Households)
Problems with the water supply service		
Water pressure	51%	27%
Supply hours	37%	31%
Price	36%	17%
Water quality	31%	7%
Supply cut (over one day)	18%	12%
Maintenance	6%	2%
Customer service	4%	0%
No problem	10%	49%
Satisfaction level with the water supply service		
Very much satisfied	1%	9%
Satisfied	20%	47%
Slightly satisfied	33%	28%
Slightly dissatisfied	39%	12%
Very much dissatisfied	7%	5%
Change of the water supply service before and after the Project (Improved % minus Worsened %)		
Water pressure	9 points	29 points
Supply hours	5 points	9 points
Supply cut	32 points	2 points
Water quality	37 points	26 points
Tariff	-25 points	-9 points
Maintenance	12 points	6 points
Customer service	12 points	-18 points
Change of the water supply service before and after the Project		
Greatly improved	28%	21%
Slightly improved	36%	45%
No change	17%	22%
Slightly worsened	14%	6%
Greatly worsened	3%	2%
Change of household water supply before and after the Project (Improved % minus Worsened %)	53 points	61 points
Problems with the sewerage service		
Spillage	5%	10%
Bad odor	6%	2%
Maintenance problem	3%	2%
Other	1%	0%
No problem	87%	91%
Satisfaction level with the sewerage service		
Very much satisfied	2%	14%
Satisfied	83%	69%
Slightly satisfied	2%	12%
Slightly dissatisfied	11%	2%
Very much dissatisfied	1%	1%
Change of household sanitation before and after the Project (Improved % minus Worsened %)	63points	70points
Reasons for improvement of household sanitation (Ratio of households pointing out each reason among those households which agreed with improvement)		
Availability of safe water to use	56%	80%
Improvement of hygienic practices	66%	61%
Improvement of sewage and waste treatment	56%	12%
Improved quality of drinking water	53%	68%
Improvement of neighborhood sanitation before / after the Project (Improved % minus Worsened %)	40%	62%
Frequency of diarrhea before and after the Project		
Increased	4%	2%
Decreased	43%	31%