Republic of Peru

FY 2015 Ex-Post Evaluation of Japanese ODA Loan Projects

"Lima Marginal Areas Sanitation Improvement Project"

"Lima Marginal Areas Sanitation Improvement Project (II)"

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

0. Summary

The Lima Marginal Areas Sanitation Improvement Project and the Lima Marginal Areas Sanitation Improvement Project (II) (hereinafter these are together referred to as "the Project") were implemented to expand and improve the water supply and sewerage services in marginal areas of the northern Lima Metropolitan Area (hereinafter referred to as the "LMA") by means of constructing a new water treatment plant (hereinafter referred to as the "WTP") and improving the water supply and sewer networks, thereby contributing to improvement of the living conditions in these areas. The water supply and sewage management sector has consistently been a priority development sector for the Government of Peru since the time of appraisal to the time of ex-post evaluation. At the time of appraisal, there was a great need for the development of water supply and sewer systems, and the facilities constructed or improved under the Project play an important role at the time of ex-post evaluation. The Project was relevant to Japan's ODA policy at the time of appraisal. Based on the above, the relevance of the Project is high. Of the planned facilities under the Project, the construction of the Huachipa WTP and North Branch Water Transmission Line (hereinafter referred to as the "North Branch") was implemented after postponement of six years as a result of review of the water demand in the LMA. Meanwhile, the construction work to connect the North Branch to the existing water supply networks is not fully completed at the time of ex-post evaluation due to cancellation of the relevant contract with the contractor. Because of these delays, the project implementation period has more than trebled compared to the plan. The project cost has almost doubled due to price increases and an increased work volume. Therefore, the efficiency of the Project is low. The expansion of water supply and sewerage services following the consolidation of the water supply and sewer systems under the Project have achieved nearly 90% of the original targets. The intended effects of the Project have been generally achieved as planned. These include the expansion and improvement of the water supply and sewerage services and improvement of the living conditions for households with new connections as well as existing connections. The water production volume of the Huachipa WTP, on the other hand, is currently only one-quarter of the planned volume due to the delayed connection work to the existing water supply networks. Therefore, the effectiveness and impact of the Project is fair. As no specific problems are observed with the institutional, technical and financial aspects of the operation and maintenance of the Project, the sustainability of the Project is high.

In conclusion, the Project is evaluated as being partially satisfactory.

1. Project Description

Project Location

Huachipa Water Treatment Plant

1.1 Background

In the second half of the 1990's, the LMA with the largest population (some 7.5 million in 1998) in Peru was suffering from a severe water shortage in the dry season. According to Lima Sanitation Service Company (hereinafter referred to as "SEDAPAL")[1], while SEDAPAL was making efforts to develop new water sources in the Andes Mountains, the water source area, it found it necessary to enhance the water treatment capacity in parallel.

Meanwhile, the inflow of low income people from rural areas to the LMA accelerated the rapid urbanization of its peripheral areas. In the northern LMA, many of these migrant people with low income occupied public land around the existing urban areas, forming new residential areas. Many of these areas were on hillsides. As their living conditions were very poor and public services including water supply and sewer services were unavailable, the expansion of these services to include these areas was necessary.

Against this background, the Project aimed at improving the water supply and sewer systems in the northern LMA while also constructing a new WTP. In 1999, a fact-finding mission was dispatched to the LMA following a request by the Government of Peru for ODA. This was followed by project appraisal and an ODA loan agreement for the Project (Lima Marginal Areas Sanitation improvement Project) in 2000. To supplement an increased project cost, an additional loan was provided for the second phase of the Project (Lima Marginal Areas Sanitation improvement Project II) in 2010.

1.2 Project Outline

To expand and improve water supply and sewerage services in local residential areas of the northern LMA of Peru by means of constructing a new WTP (intake facility, treatment plant and trunk transmission line) and also developing water supply and sewer networks in the

[1] *Empresa Prestador de Servicio SEDAPAL Sociedad Anónima*

subject areas, thereby contributing to improvement of the living conditions in these areas.

Loan Approved Amount/ Disbursed Amount	(I) 24,854 million yen/24,818 million yen (II) 9,301 million yen/9,301 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	(I) 4 September, 2000 (II) 15 March, 2010	
Terms and Conditions	Interest Rate	(I) Main component: 1.7%; consulting service: 0.75% (II) Main component: 1.4%; consulting service: 0.01%
	Repayment Period (grace period)	(I) Main component: 25 years (7 years); consulting service: 40 years (10 years) (II) Main component: 25 years (7 years); consulting service: 25 years (7 years)
	Conditions for Procurement	(I) Main component: general untied; consulting service: bilateral untied (II) Main component: untied; consulting service: untied
Borrower/Executing Agencies	Republic of Peru / Lima Sanitation Services Company (SEDAPAL)	
Final Disbursement Date	(I) 25 August, 2011; (II) 20 December, 2010	
Main Contractors (Over 1 billion yen)	CONALVIAS LTDA (Columbia); GYM S.A. Peru); T&D SIGMA ASOCIADOS (Peru); COBRA INSTALACIONES Y SERVICIOS S.A. (Span); CAMARGO CORREA (Brazil); OTV SA (France); GALVAO ENGENHARIA S.A. (Brazil)	
Main Consultants (Over 100 million yen)	Nippon Koei Co. Ltd. (Japan); CESEL S.A. (Peru); OIST (Peru)	
Related Study	Project Formulation Study for the Project for Strengthening of Water Supply in Lima (Huachipa Treatment Plant)	
Related Projects	Project for Optimization of Water Supply and Sewerage in Northern Lima Metropolitan Area [(1) 2009–, (2) 2013–]; Pomacocha – Rio Blanco Water Resource Transfer Project (MARCA II) (terminated after the detailed design)	

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan, Inc.)

2.2 Duration of the Evaluation Study

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

Duration of the Study: March, 2016 – March, 2017

Duration of the Field Survey: 30 July – 16 August and 29 October – 3 November, 2016

3. Results of Evaluation (Rating: C[2])

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance to Development Plan of Peru

At the time of appraisal (2000), many of the poor people accounting for half of Peru's population were concentrated in mountain regions and the LMA. Considering the elimination of poverty to be its biggest challenge, the Government of Peru had been aiming at providing necessary infrastructure, including social infrastructure relating to sanitation, education and health care, throughout the country in addition to assistance for production activities to improve the income level to allow the poor people to participate in the national economy. Emphasis was placed in particular on sanitation-related infrastructure as it was the most essential requirement for everyone's life and water supply and sewerage improvement projects were implemented nationwide.

The Second Garcia Administration inaugurated in 2006 (2006 – 2011) substantially increased the amount of public investment in the water supply and sewerage sector under the slogan of "Water for All"[4]. The Medium-Term Strategy (target period: 2016 – 2021) prepared by the Ministry of Housing, Construction and Sanitation in 2015 adopted "increased access to high quality and sustainable water supply and sanitation services in urban and rural areas" as a strategic objective. In regard to the improvement of water supply and sewerage services in local cities, the strategy plans to strengthen the operational capability of local sanitation service companies, participation of the private sector and consolidation of the sustainability of services were stated. The Kuczynski Administration inaugurated in 2016 upholds the water and sanitation sector as one of its priority sectors.[5]

As such, relevancy of the Project to the development plans of the Government of Peru is high both at the time of appraisal and ex-post evaluation.

3.1.2 Relevance to the Development Needs of Peru

As already described in 1.1 Background of the Project, the development of water resources and enhancement of the water treatment capacity were necessary in the LMA at the time of appraisal. At the time, SEDAPAL predicted that the water demand in the LMA in 2015 would be 33.1 m^3/sec, meaning that the development of new water supply sources and enhancement of the water treatment capacity to provide at least an additional 8 m^3/sec would be needed by 2015. The water supply and sewerage coverage ratio in the LMA at the time was

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

3 ③: High; ②: Fair; ①: Low

4 According to data provided by the Ministry of Housing, Construction and Sanitation, the ratio of the public investment amount in the water supply and sewerage sector to the GNP has improved to 0.6 – 0.8% in the period from 2009 to 2016 from 0.1% or less up to 2005.

5 The election manifesto of the PPK (*Peruanos Por el Kambio*), the current government party, calls for "Potable Water for All" as part of its social development policies, aiming at providing all people of Peru with water supply and sanitation services by 2021.

approximately 85% and expansion of the water supply and sewerage services to new suburban residential areas experiencing a rapid population increase posed an immediate challenge.

As described later in 3.3 Effectiveness, at the time of this ex-post evaluation, the facilities either improved or newly constructed under the Project are playing an important role of providing water supply and sanitation services in the northern LMA with an acute population increase. The latest water supply and sewerage master plan (2014 – 2029) of SEDAPAL envisages population, water demand and sewerage volume increases by 22%, 18% and 19% respectively in the 15 year period from 2014 to 2030, calling for continuous development of water sources, water treatment, transmission and distribution facilities and sewerage facilities. This means that the importance of the Project has been maintained at the time of ex-post evaluation.

3.1.3 Relevance to Japan's ODA Policies

Japan's *Country Assistance Program for Peru* (2000) at the time of appraisal identifies "poverty reduction", "support for the social sector", "development of economic infrastructure" and "environmental conservation" as priority fields. The relevance of the Project to Japan's ODA policies can be identified through the policy of "poverty reduction" which calls for "the continuous promotion of cooperation primarily centering on the development of water supply and sewerage facilities as basic living infrastructure". The listing of measures to combat water pollution as part of "environmental conservation" is further evidence of the relevance of the Project to Japan's ODA policies.

Based on the above, the Project has been highly relevant to the country's development plan and development needs as well as Japan's ODA policies and, therefore, its relevance is high.

3.2 Efficiency (Rating: ①)

3.2.1 Outputs

The original plan for the Project envisaged that the Project would consist of two components described below. Although a request was made by the Government of Peru for Japanese ODA for each component as two separate projects, these two components were combined into a single project after their discussions at the time of appraisal.

<Component ①>

Construction of the Huachipa WTP Phase 1 (including intake facilities) to draw water from Rimac River and also of the North Branch to convey water from the Huachipa WTP to the northern LMA. The construction of the Huachipa WTP was planned in two

phases (Phase 1 with a treatment capacity of 5 m^3/sec and Phase 2 with an additional treatment capacity of 5 m^3/sec) and the Project corresponded to Phase 1. The capacity of the intake facilities to be constructed under the Project was planned to be 10 m^3/sec on the assumption that the Phase 2 construction of the Huachipa WTP would be implemented at a later stage. In Phase 2 scheduled to start in 2017 or later, the construction of a southern transmission pipeline (the South Branch) to convey water to southern LMA is planned along with the expansion of the treatment capacity of the Huachipa WTP.[6]

<Component ②>

Construction of general and secondary water supply and sewer networks in 18 districts of northern LMA.[7] It was planned that water supply in these 18 districts would rely on such water sources as wells, existing WTPs and the Huachipa WTP to be constructed under the Project. The work for the general water supply and sewer networks included the construction and improvement of wells, distribution reservoirs and principal pipelines. In some districts, connection to the North Branch was included in the scope of work. Meanwhile, the work for the water supply and sewer systems for secondary networks included the work to newly connect water supply and sewer pipes to some 50,000 low income households, mainly in the new residential areas.[8]

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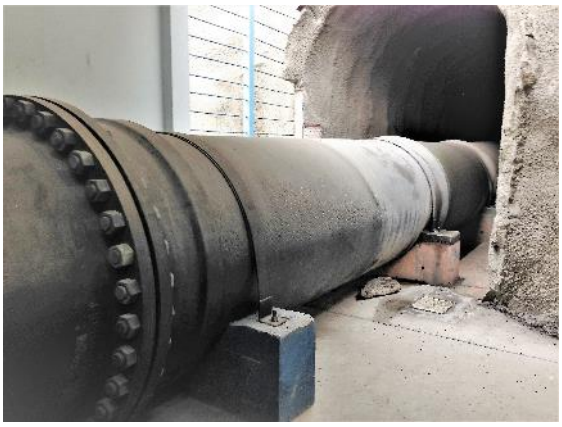
[6] To deal with the increasing water demand of the LMA, SEDAPAL in conjunction with the Private Investment Promotion Agency (*Agencia de Promoción de la Inversión Privadas*: PROINVERSION) is preparing to implement a project of which the scope includes the development of water sources in the Andes Mountains, Phase 2 of the Huachipa WTP (expansion of the treatment facility) and construction of a southern transmission line to convey water to southern LMA through concession contracts with the participation of private sector investors. The contract period of this project and the contract amount are planned to be 30 years and US$ 600 million. Once completed, the Huachipa WTP will achieve a water production capacity of 10 m^3/sec using the intake facilities constructed under the Project. According to SEDAPAL, the procurement procedure started in February, 2014 and the selection of a contractor(s) is in progress. The work may commence some time in 2017 if the project is approved by the new administration.

[7] "Districts" in the target area of the Project were determined at the time of the planning of the Project to reflect the geographical locations of the water supply and sewerage facilities to be constructed or improved within the geographical coverage of the Project and, therefore, do not reflect compartments for water distribution of the SEDAPAL nor administrative divisions of the local government.

[8] The target households for water supply connection and sewer connection are generally the same. However, their respective number slightly differs because some households have an existing water supply or sewer connection.

Intake Facility for the Huachipa WTP



Exit of a Tunnel of the North Branch

Table 1 Comparison between Planned and Actual Outputs

Item		Planned	Actual
<Component ①>			
Huachipa Water Treatment Plant			
Intake facilities:	Intake facility	10 m^3/sec	As planned
	Conveyance pipeline	5 m^3/sec	As planned
Water treatment plant:	Treatment capacity	5 m^3/sec	As planned
North Branch			
Transmission pipelines (length)		26.4 km	As planned
Distribution reservoir (distribution tank)		5 sites	4 sites
<Component ②>			
General water supply and sewer networks			
Water Supply Service:	Construction of well	6 sites	0 sites*
	Improvement of well*	42 sites	61 sites
	Construction of distribution tank	75 sites	64 sites
	Improvement of distribution tank	38 sites	91 sites
	Laying of distribution pipes	174.0 km	134.9 km
Sewerage Service:	Sewer pipelines	19.9 km	51.7 km
Introduction of SCADA and distribution compartments**		No plan	Introduced
Secondary water supply and sewer networks			
Number of new water supply connections		52,000	43,836
Number of new sewer connections		27,000	43,760
(Total number of new connections)		(99,000)	(87,596)

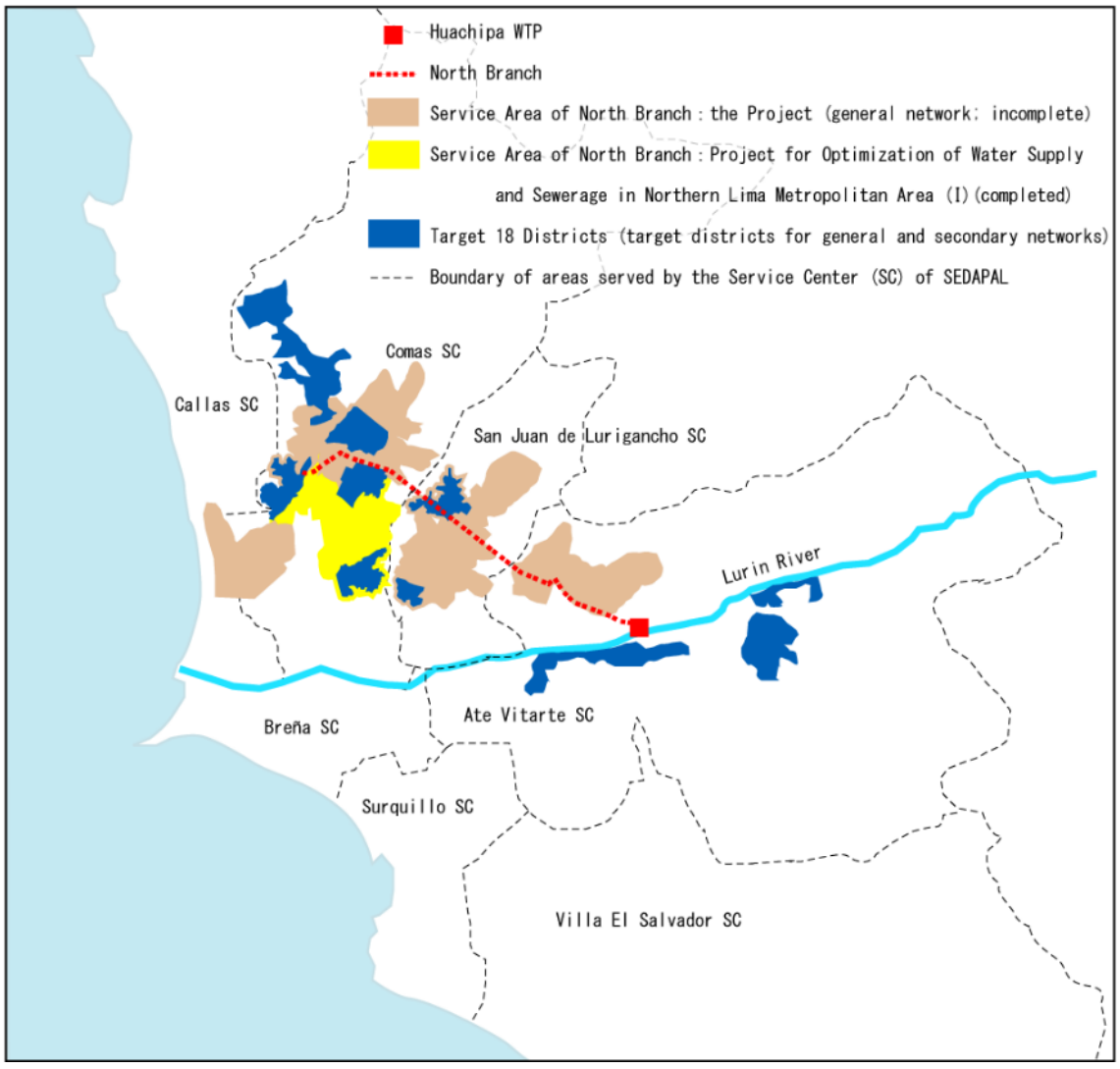
Source: Materials provided by JICA and SEDAPAL

Notes: * At one of the wells for improvement, it was necessary to drill a new well at the same site because of severe damage to the existing well. This newly drilled well is, however, classified under "improvement of well".

** SCADA (Supervisory Control and Data Acquisition) System is a remote supervisory control system using telemetry. The compartmentation of water distribution is conducted for the principal purpose of achieving an adequate and uniform distribution pressure, sophisticating water management and localizing any work or damage due to an accident. It is also called "sectorization". Compartmentation creates many small compartments where water flow can be controlled by valves and meters. SCADA is often introduced together with compartmentation to enable water pressure adjustment in correspondence with the water pressure of the transmission pipelines and level of real-time water consumption. Apart from reducing the water leakage, SCADA can limit the areas and duration of water outage as the closure of individual compartments can be remotely conducted when implementing measures against water leakage or civil works.

New Residential Area with
an Expansion of Networks

Distribution Reservoir constructed
by the Project



Source: Prepared using the materials provided by SEDAPAL

Figure 1 Target Area of the Project and Target Water Supply Areas of the Huachipa WTP

Regarding the relationship between the two components, it was planned that five districts of the 18 subject districts of Component ② would use the Huachipa WTP which constituted Component ① as a water source.[9] Meanwhile, water conveyed through the North Branch from the Huachipa WTP was planned for wider distribution throughout the northern LMA, including the said five districts.

The loan agreement for the Project was signed in September 2000. However, following political and economic confusion caused by changes of the administration twice in the immediate aftermath of the signing, the Toledo Administration inaugurated in July 2001 attempted to tighten the government's financial disciplines and substantial restraint of fiscal expenditure in the public sector.[10] As a result, the water demand forecast for the LMA was recalculated and it was judged that there would be no need to rush for the construction of the Huachipa WTP, considering the water saving effect on the part of users brought about by wider dissemination of water meters, for example.[11] SEDAPAL then made a request to JICA to postpone the construction of the Huachipa WTP and North Branch and JICA agreed with this request in July 2002.

In the following year, a consulting service agreement was signed and improvement of the general and secondary water supply and sewer networks was conducted in 18 districts (Component ②) through 11 contracts from 2004 to 2009. This was followed by the decision of SEDAPAL to construct the Huachipa WTP and North Branch (Component ①) in 2007. The work for this WTP and the North Branch began in October 2008 based on a contract whereby the contractor was responsible for the design, construction and operation of the new facilities for a period of four years after their completion. The construction work was completed in 2014.

The work to construct the general water supply network connecting the North Branch to the existing water supply network (Component ②) began in 2010 and was mostly completed by 2014. The entire work was completed and delivered in seven out of 13 work zones which constitute the contract. However, the work was not completed and delivered in the case of the remaining six work zones because of incompletion of the SCADA system.[12] As the contractor could not complete it, SEDAPAL cancelled the contract in September 2015 after receiving

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9 The planned water sources for the other 13 districts were the existing La Atarjea WTP, Chillon WTP planned under a different project and groundwater.

10 Immediately after the signing of the Loan Agreement in September, 2000, President Fujimori resigned in November, 2000. The Toledo Administration was inaugurated in July, 2001 after a provisional administration. In 2002, the Fiscal Responsibility Act was enacted to restrain fiscal expenditure in the public sector.

11 At the time of appraisal, it was predicted that the water demand in the LMA in 2015 would be 33.1 m^3/sec. As a result of the review, the figure was reduced to 23.5 m^3/sec. However, the latest forecast by SEDAPAL (26.9 m^3/sec based on the master plan prepared in 2014) exceeds this revised figure. In sort, while the actual level of the water demand at present is lower than the forecast made at the time of appraisal, it is considered to be higher than the revised forecast.

12 According to the explanation given by SEDAPAL, one of the reasons for SEDAPAL's non-acceptance of completion and delivery in the six work zones was that water leakage was found at many joints of the newly laid pipes. There is an ongoing dispute between SEDAPAL and the contractor regarding the cause of such leakage and no conclusion has yet been reached at the time of this ex-post evaluation.

JICA's no objection letter. It is currently planned that SEDAPAL will carefully examine the required works to complete and sign a new contract using its own funds for the full completion of the remaining work by the end of 2017.

Planned and actual outputs of the Project are shown in Table 1, and geographical relationship between the target areas and the facilities under the Project is shown in Figure 1.

The Huachipa WTP has achieved the planned intake and water treatment capacities. The actual facilities constructed are compact and use a technology designed to make the footprint as small as possible as the actual size of the site is 5 ha instead of the planned 10 ha due to a problem concerning land registration. This technology enables continuous coagulation, flocculation and sedimentation in one process. Consequently, the operability of the Huachipa WTP is much better than that of the existing La Atarjea WTP located in the downstream. This change of the design is judged to be reasonable in the face of the restrictive site conditions.

Five distribution reservoirs were originally planned for the North Branch. The difficulty of acquiring land at one site and the discovery of ancient remains at another site led to construction of a distribution reservoir with a capacity equivalent to two reservoirs at a different site. As a result, the number of distribution reservoirs actually constructed was reduced to four. Moreover, the tunnel size was enlarged to facilitate speedy construction work and to secure space for maintenance work. These changes are also judged to be reasonable in view of (i) the local conditions at the time of construction and (ii) necessity for construction and maintenance.

The planned contents of the general and secondary water supply and sewer networks underwent many changes in the 18 districts. It is difficult to conduct a detailed comparative analysis of the planned and actual outputs in this regard because of the unavailability of drawing plans prepared at the time of appraisal. The principal changes explained by SEDAPAL are described below.

Water Sources

- The postponed construction of the Huachipa WTP made it necessary to change the planned water sources to wells or other WTPs in five districts where water supply from the Huachipa WTP had been assumed.
- Based on the review of the production volumes of existing wells together with the utilization of the Chillon WTP[13] which was constructed in 2002, no new water source was developed while utilizing those existing wells which were not in use.

[13] The reference materials provided by JICA indicates the use of the Chillon WTP as the water source for multiple districts but the detailed design report compiled after the review of the F/S mentions that the project planned after the F/S assumes only wells as water sources. The evaluator infers that the construction of the Chillon WTP was not finalized at the time of the review of the F/S.

General water supply and sewer networks

- Following the postponement of the construction of the Huachipa WTP and North Branch, construction of the facilities to connect five districts (out of 18 districts) to the water supply network using the North Branch was suspended. These facilities were later included in the scope of the Project when the work was restarted to construct the Huachipa WTP and North Branch. At that time, the subject area for the construction of the general networks was expanded as the scope of the ODA loan under the Project newly included the general water supply networks required for connection with the North Branch in some other districts (other than the 18 districts under the Project) using water from this transmission line.
- Compartmentation of the subject area for water supply distribution and the SCADA system were newly introduced.[14]
- Due to an increased amount of sewage following the expansion of new residential areas and population increase, there were many instances where the existing small diameter sewer pipes had to be replaced by larger pipes, increasing the overall work volume to lay new sewer pipes.
- Other changes included changes of the pipeline routes due to expansion of paved roads, actual ground conditions and changes in location of new distribution reservoirs in response to requests by local residents.
- As the actual improvement work of the distribution reservoirs included relatively minor improvements (for example, erection of fencing) not assumed at the time of planning, the actual number of sites for improvement increased.

New Connections to Water Supply and Sewer systems

- The planned number of new connections was estimated in 2000 and actual new connections were conducted reflecting the actual needs. Because of the expansion of new residential areas, the target number of households for new sewer connection in the project area is believed to have exceeded the planned figure.
- Meanwhile, the Project adopted certain criteria (plot size and income level, etc.) for new household connections so that new connection was especially available at a low cost for low income households. Some of the originally targeted households failed to meet these criteria (for example, due to a high level of income) while others could not be connected due to the lack of document certifying land ownership or land use rights despite meeting the criteria.

[14] SEDAPAL began to conduct compartmentation starting at the central LMA area in1997. In the northern LMA, this practice was first conducted at the time of the detailed design for the Project. Compartmentation is conducted for the principal purpose of achieving an adequate and uniform distribution pressure, sophisticating water management and localizing any work and damage due to an accident. It is also called “sectorization”.

- As a result, the final number of newly connected households was slightly lower than planned. Those households which were not connected within the scope of the Project (not low income households) were later connected under the standard connection procedure used by SEDAPAL.

3.2.2 Inputs

3.2.2.1 Project Cost

Table 2 shows the planned and actual project costs. The total project cost was approximately 58.2 billion yen, exceeding the planned cost by 25.1 billion yen or 76%. The total ODA loan amount was approximately 34.1 billion yen compared to the planned amount of 24.9 billion yen (an increase of 37%). To supplement the increase of the project cost, an additional loan of 9.3 billion yen was extended in 2010. The main reasons for the increase of the project cost are listed below.

- Price increases against the background of the delayed start of construction work by 3 to 8 years[15].
- Increase of construction cost due to the tunnel size expansion for the North Branch, adoption of a water treatment technology requiring less space and an increase of the pipe laying cost necessitated by different geological conditions
- Increase of the consulting service cost due to extension of the construction work period.
- Expansion of the subject areas for the general water supply network to be connected to the North Branch

As for the cost for land acquisition, it was far below the planned amount as there were many cases where public land was obtained without cost.

[15] The consumer price index in Peru increased by more than 50% from 1999 when the project cost was estimated to 2015. In 2008, the transport cost, payment for engineers and prices of such materials as ductile cast iron pipes, etc. considerably increased due to adverse influences of the international financial crisis.

Table 2 Planned and Actual Project Costs

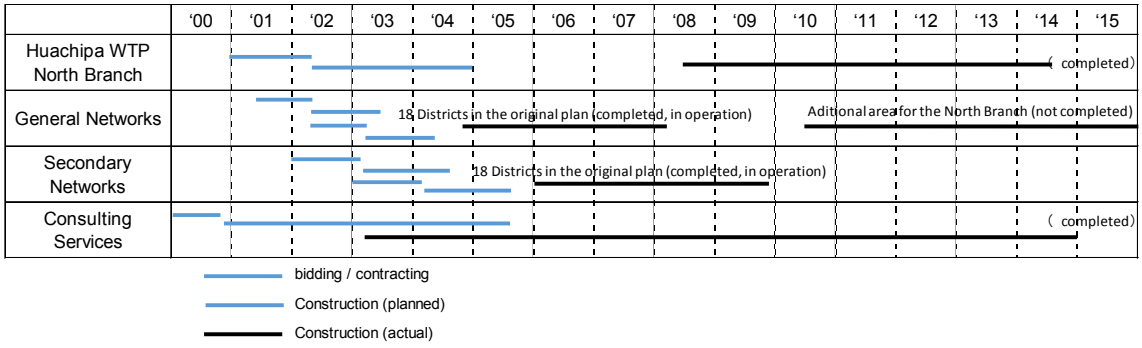
(Unit: million yen)

	Planned (at the time of Appraisal)			Actual			
	Loan	Peru	Total	Loan	Peru	Total	Percentage against Plan
Huachipa WTP and North Branch	12,007	0	12,007	14,865	9,699	24,564	204.6%
General water supply and sewer networks	4,578	0	4,578	7,067	5,138	12,205	266.6%
Secondary water supply and sewer networks	4,850	0	4,850	8,611	266	8,877	183.0%
Land	0	775	775	0	36	36	4.7%
Administration Cost	0	642	642	0	1,369	1,369	213.3%
Contingency Cost	594	1,692	2,286	-	-	-	-
Consulting Service	2,825	0	2,825	3,551	648	4,199	148.6%
Taxes	0	5,175	5,175	0	6,975	6,975	134.8%
Total	24,854	8,284	33,138	34,094	24,132	58,227	175.7%

Source: Data on planned costs by JICA documents and data on actual costs by SEDAPAL documents
Note: The project cost for the general water supply and sewer networks includes the cost of the incomplete work relating to the North Branch. The actual costs are those up to the time of ex-post evaluation.
Foreign exchange rate: (Planned) 1 US$ = 113.5 yen; 1 nuevo sol = 34.0 yen
(Actual) 1 US$ = 101.0 yen (the rate actually applied)

3.2.2.2 Project Period

Following the signing of the loan agreement in March 2000, the Project (the first phase) was scheduled for completion in September 2005 (67 months). In reality, however, a part of the project scope has not yet been completed, meaning a substantial extension of the project period. The actual project period up to the second field survey for the ex-post evaluation was 201 months (March 2000 to November 2016), trebling the originally planned project period.[16] Figure 2 shows the planned and actual project periods.



Source: Data on the planned period by JICA documents and data on the actual period by SEDAPAL

Figure 2 Planned and Actual Project Periods

[16] SEDAPAL plans to complete the construction of all of the facilities by the end of 2017.

As mentioned earlier, the consulting services for the Project commenced in 2003, two and a half years later than planned. In subsequent years up to the end of 2009, a series of work, including the detailed design, procurement and construction of the general and secondary water supply and sewer networks other than the general water supply networks connecting to the North Branch, was conducted in sequence based on 12 separate construction contracts. The work to construct the general and secondary water supply and sewer networks took place in stages due to financial constraints on the part of the Government of Peru, unsuccessful tenders and other reasons. In some areas, the construction period was extended due to changes of the plan for some facilities after the commencement of the work, handling of local residents who refused to agree to the construction of new facilities and handling of local residents appealing to violence to seek employment.

In February, 2007, SEDAPAL decided to commence the once postponed construction of the Huachipa WTP and North Branch and the work started in October 2008 with a DBO (design, build, operation) contract. The operation period included in the contract was four years after the completion of the build stage.[17] Although the planned completion date at the time of the signing of the contract was May 2011, the actual construction work was delayed at some sections of the North Branch due to the change of the number of distribution reservoirs from five to four and the much rockier ground conditions than anticipated for the tunnel sections. Because of this, the construction period was divided into three phases. Phase 1 involving the Huachipa WTP and the adjacent section of the North Branch was completed and delivered in July 2011. A rupture incident in February 2012 at the section handed over of the North Branch required more than one year to amend. All of the planned facilities were completed and delivered in July 2014.[18]

The construction work of the general networks to be installed in districts to receive water supply from the North Branch began in August 2010 after the detailed design and procurement stages. The construction work which was originally planned to last for one year was mostly completed in 2011 despite a slight delay due to changes of the plan for some facilities and a need to conduct additional investigation on newly found ancient remains. A

[17] The Pomachocha-Rio Blanco Water Resource Transfer Project (MARCA II), a ODA loan project which was supposed to supply raw water to the Huachipa WTP, was canceled after the detailed design stage due to the same reason for the postponed construction of the Huachipa WTP. However, the supply of raw water for the Huachipa WTP has been secured by another water source development project (MARCA III Project, commencing operation in 2012).

[18] A section of the North Branch which began operation in July 2011 ruptured, causing a major water leakage in February 2012. SEDAPAL suspended its operation for more than one year to investigate the cause of this incident and to find measures to prevent a recurrence. This investigation concluded that the rupture of the steel pipeline was triggered by an increased inner pressure due to sudden valve operation against the background of; the joint of the steel pipeline being out of alignment due to erosion of the base of the pipeline, the quality of the steel pipes involved and damages to them during transportation and water leakage from the air valve. As emergency measures, the study team recommended drainage of the water around the air valve and slower valve operation. These recommendations were immediately put into practice and the entire North Branch was reopened in August 2014, commencing water supply operation to match the water demand of the newly connected areas.

hydraulic test was conducted in 2014 after the implementation of new measures to deal with the rupture incident with the North Branch. The contract was cancelled in September 2015 as explained earlier even though some work sections were not completed for delivery.

3.2.3 Internal Rate of Return (for reference)

Of the various components of the Project, the financial internal rate of return (FIRR) was recalculated for the Huachipa WTP and North Branch based on a project life of 30 years, such expenses as overall construction cost and maintenance cost and such benefits as the revenue from the water charge and reduction of the cost for the pumping of groundwater. The resulting figure of 8.5% was lower than the 15.9% calculated at the time of planning. Meanwhile, the economic internal rate of return (EIRR) where the taxes are deducted from the expenses was calculated to be 10.8% (the EIRR was not calculated at the time of planning). The main reason for the recalculated FIRR being lower than the previous estimate is believed to be more than doubling of the overall project cost.

Both the project cost and project period significantly exceeded the plan. Therefore, the efficiency of the Project is low.

3.3 Effectiveness[19] (Rating: ②)

3.3.1 Quantitative Effects (Operation and Effectiveness Indicators)

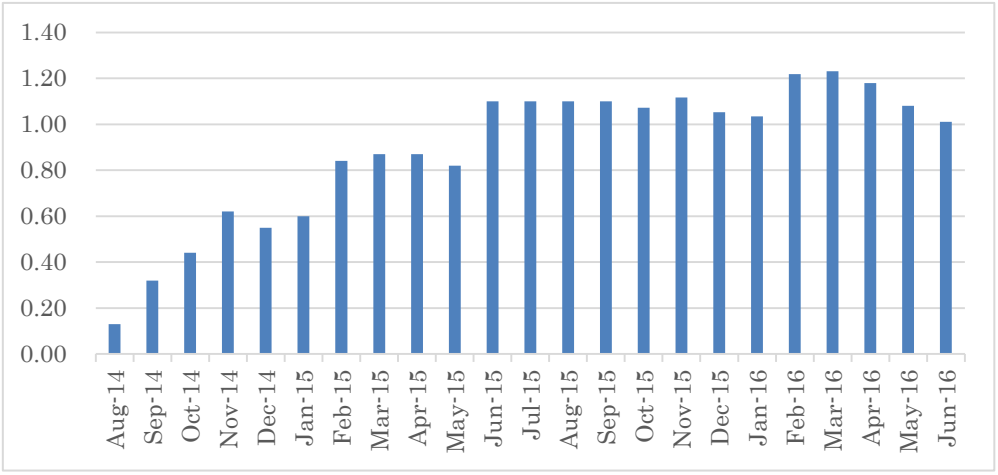
The purpose of the Project was "to expand and improve water supply and sewerage services in marginal areas of the northern LMA of Peru by means of constructing a new WTP (intake facility, treatment plant and trunk transmission line) and also improving the water supply and sewer networks in the subject areas". In the following sections, the state of achievement of the planned objectives is analyzed for each of the two components of the Project.

(1) Construction of the Huachipa WTP and the North Branch (Component ①)

Water production at the Huachipa WTP began in August 2014 and the level of production has been fairly constant at 1.0 to 1.2 m^3/sec since June 2015 (Figure 3). This volume is equivalent to water consumption of roughly, 110,000 to 130,000 households. The maximum production level recorded up to June 2016 was 1.23 m^3/sec recorded in March 2016 which was equivalent to 25% of the planned 5 m^3/sec.[20] The lower production level at the Huachipa WTP than the target is attributed to the slow progress of the construction of the general water supply networks to be connected to the North Branch as explained next.

[19] The effectiveness is rated in consideration of not only the effects but also the impacts.
[20] The plan at the time of appraisal assumed that the production volume of 5 m^3/sec would have been achieved in 2005.

(Unit: m^3/sec)



Source: SEDAPAL

Figure 3 Water Production Volume at the Huachipa WTP

The entire volume of treated water produced at the Huachipa WTP is fed to the North Branch. It is planned to connect the North Branch to the secondary water supply network via the general water supply networks constructed under projects shown in Table 3.[21] Therefore the Huachipa WTP cannot produce a volume of water corresponding to the local demand as water distribution is not possible until such time when the connection facilities are constructed. At the time of the ex-post evaluation, the facilities constructed under the "Project for the Optimization of the Water Supply and Sewerage in Northern Lima Metropolitan Area (1)" (a different project) and facilities constructed under the Project in one work zone out of the 13 work zones constitute the only operational general water supply networks connected to the North Branch. The water production volume at the Huachipa WTP is expected to increase in line with further completion of facilities planned under each of these projects.

The water produced at the Huachipa WTP fully satisfies the required quality standards for residual chlorine and turbidity since the start of its operation. As no E. coli has been detected, there are no problems with the quality of water produced at the Huachipa WTP.

[21] It was originally planned under the Project to construct the necessary facilities for connection to the North Branch as part of the general water supply networks so that five districts could receive water supply from the Huachipa WTP out of the 18 districts subject to the development of the general and secondary water supply networks. Meanwhile, there was no clear indication of which districts other than these five districts would be subject to water supply from the Huachipa WTP and how the connection work to such additional districts would be implemented. Following the postponement and restart of the work to construct the Huachipa WTP and the North Branch, it was decided to include the facilities required for connection to the North Branch in the scope of the Project as part of the development of the general water supply networks in a wider area including the originally planned five districts (as shown in Figure 1 – Service Area of North Branch; the Project).

Table 3 Plan for Water Distribution from the Huachipa WTP

Project Name	Planned Distribution Volume	State of Implementation and Remarks
Project for Improvement of Sanitation in Suburban Residential Areas of the LMA (I and II) (the Project)	2.3 – 2.4 m^3/sec	Operating in one out of 13 work zones (data for the distribution volume is not available). The entire facilities are expected to be completed by the end of 2017.
Project for Optimization of Water Supply and Sewerage in Northern LMA (I)	1.1 – 1.2 m^3/sec	In operation (joint financing project by Japan, World Bank and KfW).
Project for Optimization of Water Supply and Sewerage in Northern LMA (II)	1.1 – 1.3 m^3/sec	Expected to be completed by the end of 2018 (joint financing project by Japan, World Bank and KfW)
Cajamarquilla, Nieveria and Cerro Camote Project	0.3 m^3/sec	Expected to be completed by August of 2018 (loan project of the Inter-American Development Bank)
Expansion and Improvement of Potable Water and Sewer System in Pachacutec, Ventanilla	1.2 – 1.4 m^3/sec	Expected to be completed by the end of 2016; provisional measure until the completion of Phase II of the Chillon WTP (funded by SEDAPAL)

Source: SEDAPAL

(2) Development of general and secondary water supply and sewer networks in 18 districts of the Northern LMA (Component ②)

In the 18 target districts, the Project aimed at expanding and improving the water supply and sewerage services in marginal areas by means of improving the water supply and sewer networks. The subject area of SEDAPAL's water supply and sewerage services in the LMA is divided into seven areas served by respective service centers. The 18 target districts under the Project are included under the jurisdiction area of three (Comas, San Juan de Lurigancho and Ate Vitarte) service centers. Table 4 shows the number of water supply and sewer connections in these three service center areas and also 18 target districts of the Project.

Table 4 Number of Water Supply and Sewer Connections in the Relevant Three Service Centre Areas and 18 Target Districts

	Water Supply	Sewerage
Total number of connections under the three service centers (2015)	742,000	707,000
Total number of connections in the 18 target districts (January, 2016)	146,000	NA
Number of new connections under the Project	43,836	43,760

Source: Prepared using data provided by SEDAPAL

24-hour water supply is now available in nearly three-quarters of the 18 target districts of the Project. However, 24-hour water supply is not granted in order to suppress wasteful water consumption in those marginal areas with a high proportion of low income households, where a fixed water charge is collected due to the lack of local consent to the installation of water meters. Table 5 shows the number of connections by service center, water supply hours and water pressure in the 18 target districts at the time of ex-post evaluation. No similar information for the time before the Project has been obtained.[22]

Table 5 Situation of Water Supply Service by Service Center in the Target Area (18 Districts) of the Project

Service Centre	January, 2016 (Dry Season)			June, 2016 (Wet Season)		
	No. of Connections	Average Water Supply Hours (hrs)	Average Water Pressure (mwc)	No. of Connections	Average Water Supply Hours (hrs)	Average Water Pressure (mwc)
Comas (9 districts)	77,240	15.1	24.8	79,008	20.1	25.6
San Juan de Lurigancho (2 districts)	23,951	15.0	32.4	24,038	23.2	33.4
Ate Vitarte (7 districts)	44,332	22.6	22.1	45,145	22.8	23.0
Total/Average	145,523	17.4	25.3	148,181	21.4	26.0

Source: Prepared using data provided by SEDAPAL.

Note: The unit (mwc) for the average water pressure is the pressure capable of supporting a 1 meter water column. The relevant standard for the water supply pressure in Peru is 15 to 50 MWC.

Expansion of the Water Supply and Sewerage Services to Newly Connected Households

The planned expansion of the water supply and sewerage services in the 18 target districts was achieved by newly installed water supply and sewer connections to 43,836 households and 43,760 households respectively under the Project. The total number of connections of 87,596 is equivalent to 88% of the planned 99,000 connections (52,000 for water supply connections and 47,000 for sewer connections). This number of new connections represents some 3% of the total number of connections in the LMA. The water supply coverage ratio and sewerage coverage ratio in the LMA improved respectively by eight points (85% to 93%) and by 12 points (81% to 93%) in the 16-year period from 1999 to 2015. The Project has contributed three points to each service.

Many of the newly connected households under the Project belong to residential areas spread over sloping land and most of them are low income families who have moved

[22] At the time of appraisal of the additional loan, target figures were set for the rate of non-revenue water, number of connected households, coverage ratio, average water pressure and average water supply hours. The number of connections in the 18 target districts of the Project was only some 20% of the total number of connections under the jurisdiction area of each service center. Moreover, as target figures for improvement under the Project are not clearly set for other indicators other than the number of connected households, it is difficult to quantitatively verify the contribution of the Project. Because of this, no analysis of these indicators was conducted in the ex-post evaluation.

from rural areas to the LMA. The beneficiary survey and group interviews with residents[23] found that many of the residents of these areas used to receive water from a communal tap or water trucks operated by SEDAPAL or a private supplier but did not have any sewer connection before the Project.

Improvement of the Water Supply and Sewerage Services for Households with Existing Connection

The development of the general water supply and sewer networks under the Project is believed to have improved its relevant services for some of those households in the 18 target districts which were already enjoying water supply and sewerage services before the implementation of the Project. It is difficult to concretely determine what kind of improvement was made by the Project in each of the 18 target districts because of the complex system configuration due to the phased facility development in the past assuming more than one water source and also because of the partial and fragmented fashion of facility development under the Project. However, the findings of a series of interviews conducted at SEDAPAL's service centers suggest that there was improvement of the water supply service as a result of the Project in some of these 18 districts thanks to (i) an increase of the water supply volume through effective use of wells and new connection with existing water sources, (ii) improvement of the distribution reservoirs and pumping facilities, (iii) improvement of the existing water supply networks, and (iv) optimization of water distribution through compartmentation and the introduction of the SCADA system. In the beneficiary survey, nearly half of the households with existing connection expressed that the water supply hours, water pressure and water quality improved after the implementation of the Project (Table 6).

In regard to the sewerage service, the beneficiary survey found that one-third of the households with existing connection replied that the spillage of sewage and bad odor in the neighborhood were reduced (Table 7, below). While it is feasible that the sewerage service for already connected households has improved through the renewal of existing sewers or introduction of larger diameter sewers, it was not possible to concretely verify the contribution of the Project.

[23] As a beneficiary survey, a questionnaire survey was conducted with 206 households in the 18 target districts. Households in 13 distribution compartments were selected from 45 distribution compartments comprising the 18 target districts and avoiding geographical bias in the selection. In each distribution compartment, 15 – 16 households were sampled by means of random area sampling. The sampled households consist of 86 newly connected households and 120 households with existing connection and, in terms of the respondents, 20% were in their twenties, 17% were in their thirties, 25% were in their forties and 46% were in their fifties or older by age. In terms of gender, 29% were male and 71% were female. Along with this questionnaire survey, eight individual interviews and seven group interviews with 5 – 7 people per group were conducted targeting those people who were around.

Table 6 Improvement of Water Supply and Sewerage Services for Households with Existing Connection

	Degree of Improvement*
Water Quality	31 points
Water Pressure	26 points
Water Supply Hours	22 points
Frequency of Water Outage	2 points
Customer Service	-6 points
Maintenance	-9 points
Water Charge	-34 points

Source: Beneficiary survey

Note: The degree of improvement is determined by subtracting the percentage of respondents replying that the issue in question had worsened from the percentage of respondents replying that the issue in question had improved.

(3) Summary

Based on the above, the degree of target achievement concerning construction of the Huachipa WTP and the North Branch at the time of ex-post evaluation is low at 25% (based on the water production volume) and the degree of target achievement concerning improvement of the general and secondary water supply and sewer networks in the 18 target districts is high at 88% (based on the number of new connections). Considering (i) the equal importance of the objectives of the two components that are independent from each other and that (ii) the project cost is similar for each component, overall degree of target achievement is calculated as 57% taking an average of the two components. Even taking into consideration the additional improvement effect regarding the water supply and sewerage services for those households with existing connection in the 18 target districts, it is hard to say that the degree of target achievement of the Project is high (meaning 80% or more). Consequently, the degree of project target achievement is judged to be “fair”.

3.3.2 Other Project Effects

The relatively high elevation (390 m) of the Huachipa WTP allows water distribution by gravity, making it possible to reduce the electricity cost compared to the La Atarjea WTP or the use of groundwater.[24] Meanwhile, the water production volume using groundwater in the LMA has been controlled since the peak year of 1997 as its increase in the second half of the 1990s exceeded the sustainable level. If water production volume at the Huachipa WTP progresses as planned, it will be possible to further contain the use of groundwater and to reduce the electricity cost.

[24] According to the trial calculation of IRR mentioned in 3.2.3, 85% of the financial benefit of the Huachipa WTP and North Branch comes from the reduction of the groundwater pumping cost.

3.4 Impacts

3.4.1 Intended Impacts

The Project was expected to contribute to improvement of the environmental and sanitation conditions in the target districts based on the development of water supply and sewerage facilities. According to the beneficiary survey (Table 7), 80% of the households surveyed replied that the sanitation conditions at home had improved. Typical reasons for the perceived improvement are (i) increased availability of water, (ii) improved water quality and (iii) adequate treatment of waste water and rubbish. Such improvement may well be the result of the expanded as well as the improved water supply and sewerage services under the Project. As many respondents mentioned the improvement of sanitary practices (increased frequency of hand washing, bathing, washing and cleaning) as the reason, it appears that the Project contributed to such improvement by making sufficient safe water readily available. Meanwhile, 70% of the surveyed households replied that the sanitation conditions in the neighborhood had improved because of such reasons as "no more spillage of foul water", "elimination of bad odor" and "elimination of unsanitary toilets" (simple dug-outs in the ground). Such improvement should be considered as another contribution by the Project.

Based on the above, it is fair to say that the expected impacts of the Project regarding improvement of the environmental and sanitation conditions duly manifested as planned.[25] In contrast, manifestation of the expected impacts was low in those areas (other than the 18 target districts) that would receive water from the Huachipa WTP and the North Branch despite expectation of similar impacts as a result of an improved water supply system, as the volume of water supply from the Huachipa WTP is approximately one-quarter of that originally planned at the time of ex-post evaluation.

[25] In the beneficiaries survey, the number of replies that the frequency of occurrence of diarrhea had decreased in the last three years exceeded the number of replies that the said frequency had increased. However, the development of water supply and sewerage facilities under the Project took place 7 – 9 years ago and, therefore, these replies cannot be directly linked to the Project. Comparison between the current state and the state before the Project has not been conducted as it is difficult to obtain reliable replies because of the time span involved. According to data published by the Ministry of Health, the frequency of occurrence of diarrhea in the LMA decreased by approximately 30% between 2008 and 2014.

Table 7 Improvement of Environmental and Sanitation Conditions at Households with Existing Connections

Change of sanitation environment at home	Improved	84%
	No change	12%
	Worsened	4%
Reason for improvement*	Usability of more water	71%
	Improved sanitary practices	64%
	Improved water quality	28%
	Adequate treatment of foul water and rubbish	10%
Change of sanitation environment in the neighborhood	Improved	72%
	No change	17%
	Worsened	9%
Reason for improvement*	No spillage of foul water	38%
	No bad odor	34%
	No unsanitary toilets	20%

Source: Beneficiary survey
Note: For reason of improvement at home and in the neighborhood, the percentage figure represents those selecting the relevant answer from among those replying that the sanitation environment at home (and in the neighborhood) has improved. Multiple answers were allowed. Only the major reasons are listed in the table.

3.4.2 Other Positive and Negative Impacts

(1) Environmental and Social Impacts

In 2009, SEDAPAL conducted an environmental impact assessment (EIA) regarding the intake facilities, the WTP and North Branch and its EIA report was approved by the Natural Resources Management Agency of Peru. Environmental conservation measures regarding more than 40 items were implemented along with monitoring of the water quality, air quality and noise during the construction work in line with the environmental management plan prepared on the basis of the EIA report, and there were no adverse impacts on the environment. According to SEDAPAL, an EIA was also conducted for the construction of the general and secondary water supply and sewer networks (the timing of implementation is unknown) and no adverse impacts on the environment were found in general. No special adverse impacts on the environment by the Project are observed at the time of ex-post evaluation. On the other hand, in the Project, surveys on ruins were conducted prior to the construction according to the government regulations. As a result, the site for reservoir construction of the Northern Branch was changed because a ruin was discovered at the planned site.

As a precondition for the implementation of the Project, land acquisition was necessary at the sites for the intake facilities, the Huachipa WTP, tunnel entrances of the North Branch and the distribution reservoirs. According to SEDAPAL, a total of 12 ha of land were acquired at 57 sites and US$ 374,000 (approximately 40 million yen) was paid as compensation. Most of the affected landowners received cash compensation but some

residents opted for resettlement to an existing house elsewhere. In addition, some 80 households at sites near the tunnel entrances had to temporarily move to avoid vibration due to construction. The process of land acquisition involved such steps as initial briefing, dialogue and social support (vocational training, etc.) by the contractor for the affected communities and the entire process was supervised by SEDAPAL's social support team. According to SEDAPAL, no serious problems were encountered except that verification of the legal basis of land ownership took some time to complete.

(2) Other Impacts

In the beneficiary survey, some 40% of the households which had received water supply from a communal tap or water tanker operated by a private operator or SEDAPAL replied that the cost, labor and time to obtain water had been reduced (Table 8). People of newly or already connected households expressed such opinions during group interviews as (i) the convenience and quality of living had improved as safe water and sanitation facilities became available at home and (ii) it was easier to invite people to their home because of the improved sanitation conditions at home and in the neighborhood.

Table 8 Problems Solved Through New Water Supply Connected

(Newly connected households only; multiple answers allowed)

High cost of obtaining water	37%	Poor water quality	16%
Tiring work of fetching water	22%	Not enough water	14%
Need for extra treatment, such as boiling	21%	Waterborne illnesses	7%
Long time to get water	16%	(No specific problems	20%)

Source: Beneficiary survey

The Project has to some extent achieved its objective in terms of effectiveness, and impacts are inferred to have manifested in correspondence to the level of effectiveness achieved. Therefore, the effectiveness and impacts of the Project are fair.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

SEDAPAL has a staff strength of 2,515 employees and enjoys the highest organizational capability among the sanitation service corporations in Peru. Figure 4 shows the organizational structure of SEDAPAL. The operation and maintenance responsibility for the facilities newly constructed or improved under the Project is divided as described below.

- Production and Primary Distribution Department: Intake facilities, Huachipa WTP and North Branch (WTP Integrated Team); general water supply networks (Primary Distribution Team); pumping facilities (Pumping Operation and Maintenance Team)

- Sewerage Management Department: Main sewer networks (Primary Collection Team)
- Three service centers (Comas, San Juan de Lurigancho and Ate / Vitarte) under the North and Central Service Bureaus: secondary water supply and sewer networks

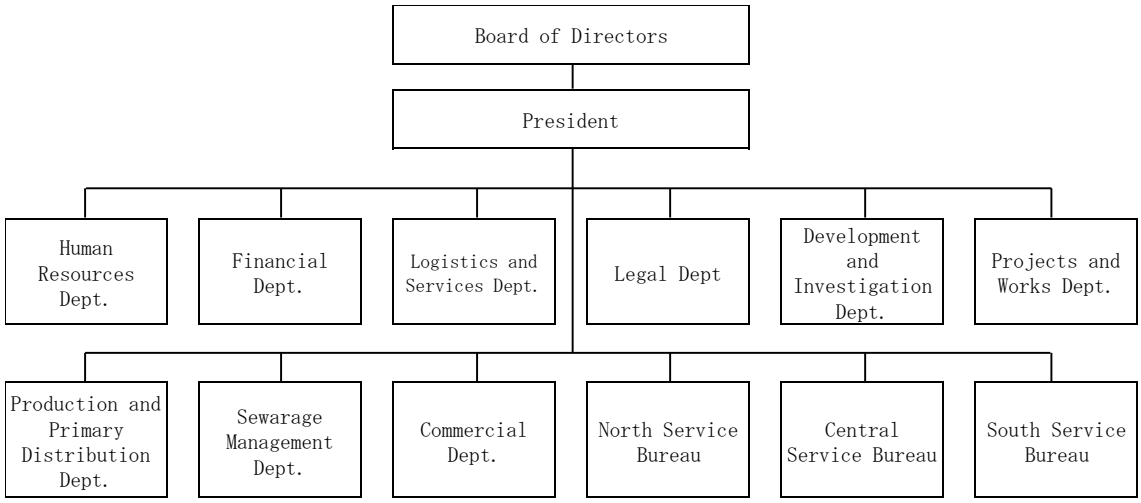


Figure 4 Organizational Structure of SEDAPAL

The contract for the Huachipa WTP and North Branch construction included a four-year post-completion operation period of these facilities by the contractor. Following the completion of this WTP in July, 2011, the WTP and North Branch were operated by the contractor. The Production and Primary Distribution Department of SEDAPAL now directly operate these facilities with a team of 23 staff members. Security, cleaning and the major repair of electrical and mechanical equipment are outsourced. According to SEDAPAL, the current staff strength is adequate but the recruitment of another 5 – 7 operation and maintenance staff members would be necessary if the production volume is increased as planned by 2018. At the Huachipa WTP, the implementation of a Phase 2 project is planned with a concession lasting for 30 years. The scope of the contract for this concession includes expansion of the WTP, construction of Marca II water sources and construction of the South Branch along with the operation and maintenance of the Phase 1 facilities of the Huachipa WTP and the North Branch constructed under the Project. The timing of the contract for the concession has not yet been finalized.

The Production and Primary Distribution Department of SEDAPAL operates the SCADA system for the main water supply networks. It also has two teams for valve-replacement, two teams for SCADA and two teams for pipeline-repair, with 5 – 6 members for each team to respond to emergency. These teams possess the necessary heavy equipment. Once damage to a pipeline or leakage is discovered, the distribution compartment in question is shut down through SCADA and the relevant service center is contacted to work

together for repair. If this work is urgent, an external contractor allocated to each service center involved may assist the repair work. According to a staff member of this department, the number of teams is not sufficient to fully cover the entire LMA.

Each service center in charge of operation and maintenance of the secondary water and sewer networks has emergency response teams to deal with incidents of leakage or blockage. In fact, emergency response is provided 24 hours a day with three shifts for the water supply service and throughout the daytime with two shifts for the sewerage service. Each service center has a high-pressure cleaning vehicle, and other necessary basic equipment to maintain the sewerage service. Workers of an external contractor are deployed at each service center and conduct such work as (i) preventive maintenance of the pipelines (replacement of old pipes and cleaning, sterilization and washing of pipelines) and (ii) emergency repair. When a leakage or blockage of foul water is reported, an emergency response team is dispatched. If repair work is found to be necessary, such work is conducted by an external contractor. While the service centers believe that the current staff strength is generally adequate, reinforcement of the emergency response teams and additional staff members to supervise the work of external contractors are required to improve speed and quality of repair works.

SEDAPAL operates some 1,500 pumping facilities which are operated and maintained by the Water Production and Primary Distribution Department. 80% of these pumping facilities are manually operated by an external contractor while the remaining 20% are operated automatically by the SCADA system. The SCADA system and pumping facilities are subject to preventive maintenance. Repair teams are stationed at three locations in the LMA for the purpose of repairing electrical and mechanical equipment and chlorine injection systems. The central workshop is capable of repairing pumps, motors, power distribution panels and chlorine injection pumps. Some repair work is outsourced.

As described above, although there appears to be some staffing shortage with the emergency response teams, the operation and maintenance system for the facilities constructed or improved under the Project is clearly established, posing no major problems.

3.5.2 Technical Aspects of Operation and Maintenance

SEDAPAL employs many engineers, possesses a human resource strengthening program and has implemented various training courses for its employees. SEDAPAL has been taking a lead to introduce such advanced technologies in Peru's water supply and sewerage sector as compartmentation for water distribution, SCADA and sewage treatment using the activated sludge process. SEDAPAL has been certified for international standards relating to quality management, environmental management, occupational health and safety, information security management and general requirements for the competence of testing and calibration laboratories. In short, it is fair to say that SEDAPAL has a high level of technical capability in

general.

According to SEDAPAL, the water treatment process at the Huachipa WTP is similar to the process at the existing La Atarjea WTP, posing no technical problems. No technical issues exist in the case of the North Branch operation either. In fact, the operability of the Huachipa WTP is said to be far better than that of the La Atarjea WTP as three treatment processes can be operated simultaneously based on the new technology introduced to cope with the limited size of plot. During the second field survey period for ex-post evaluation, the WTP operation and maintenance manual was under review based on the results of one year of actual operation. Meanwhile, there were such inconveniences as lack of drawings on-site because the trainings and transfer of other information were insufficient due to the hasty handing over of operation and maintenance work from the contractor to SEDAPAL.[26]

In relation to the Project, SEDAPAL operates three SCADA systems for the (i) Huachipa WTP, (ii) general water supply and sewer networks and (iii) pumping facilities. As they have been independently designed and installed, there is no compatibility and there are no mutual connections. However, the control room for each SCADA system can view certain information pertaining to other SCADA systems and it is possible to conduct coordinated operation to a certain extent utilizing telephone and other communication measures together. For each SCADA system, SEDAPAL may outsource the design work for system improvement or expansion and equipment repair work. Based on the explanation given by SEDAPAL on each SCADA system, SEDAPAL has built up its SCADA operating experience for nearly 20 years and it is fair to say that it has the technical capability to operate and maintain the SCADA systems with some support of outsourced contractors.

No special technologies are required for the operation and maintenance of the general and secondary water supply and sewer networks and there do not appear to be any technical issues. The relevant manuals, etc. are provided for the distribution reservoirs and pumping facilities and the daily operation and maintenance management status is recorded. A communication system is in place for emergencies and other events.

3.5.3 Financial Aspects of Operation and Maintenance

The operating profit of SEDAPAL for 2012 through 2015 was in the black with a high operating profit ratio of 20% in 2015. During this period, the current ratio was constantly high above 200%. The debt ratio for 2012 through 2014 was less than 100% in each year but increased to 140% in 2015. This was caused by a decrease in equity capital on book following a change of the accounting standards to match international accounting standards and does not mean a decline of the financial stability as a corporation. On the other hand, non-revenue water

[26] According to SEDAPAL, extension of the period of operation and maintenance by the contractor was considered but a sudden policy change led to the decision to directly manage the facilities by SEDAPAL.

rate and coverage rate of water meter installation of SEDAPL were 29.8% and 88.5% respectively in 2015. Both of these have been improved[27].

In short, the financial situation of SEDAPAL is judged to be sound and stable. Because of the scattered nature of the facilities, separate information for the operation and maintenance expenses of the facilities related to the Project was not obtained. Nevertheless, no serious problems caused by financial constraints were found regarding the operation and maintenance of the facilities constructed or improved under the Project.

Table 9 Financial Status of SEDAPAL

(Unit: 1,000 nuevos soles)

	2012	2013	2014	2015
Operating revenue (i)	1,385	1,472	1,513	1,624
Water supply and sewerage service charge	1,331	1,419	1,409	1,508
Other revenue	54	52	104	115
Operating cost (ii)	1,318	1,224	1385	1300
Cost of operation (a)	1028	904	941	949
Retail expenses	155	180	194	181
Administration cost, etc.	135	140	250	169
Operating profit (iii) = (i) – (ii)	67	248	128	323
Non-operating revenue (iv)	301	154	288	177
Non-operating cost (v)	118	85	115	293
Taxes (vi)	67	90	42	56
Ordinary profit (v) = (iii) + (iv) – (v) – (vi)	182	227	259	151
Working ratio (b)	67%	65%	76%	59%
Operating profit ratio	5%	17%	8%	20%
Current ratio (c)	212%	272%	355%	418%
Debt ratio (d)	77%	80%	82%	140%

Source: SEDAPAL

Notes: (a) Includes the operating and maintenance cost and the depreciation cost
(b) Operation and maintenance cost / operating revenue
(c) Current assets / current liabilities
(d) Liabilities / capital

3.5.4 Current Status of Operation and Maintenance

In September, 2015, it was found that the downstream side of the overflow levee had been severely scoured by the water flow at the intake for the Huachipa WTP and temporary repair work was conducted in November, 2015. SEDAPAL believes that the water flow containing much sediment may have caused a severer impact than that assumed in the project design. SEDAPAL plans to conduct a detailed investigation in due course with a view to implementing permanent measures based on the findings of this investigation.

As the sediment removal pump installed at the sedimentation basin of the Huachipa WTP cannot sufficiently remove sediments due to the minute size of grains containing water, manual removal work is conducted as required. According to SEDAPAL, sediment removal

[27] In 2005, non-revenue water rate was 41.1%, while water meter coverage was 65.8%.

requires much manpower and reinforcement of the manpower will be required when the water production volume increases in the future.

The North Branch experienced the rupture incident (previously described) in 2012. Emergency and temporal measures have been implemented based on the findings of the post-incident investigation and no problems have occurred since then. While this investigation proposed long-term improvement measures, SEDAPAL intends to decide a concrete response after further investigation.

The findings of the field surveys and results of interviews with SEDAPAL officers suggest that the operation and maintenance of the general and secondary water supply and sewer networks and pumping facilities have been adequate as no special problems have been observed with these facilities.

The SCADA systems at the Huachipa WTP and the general water supply networks are functioning properly. According to SEDAPAL, however, the measuring instruments of the SCADA system at the Huachipa WTP were not sufficiently maintained or calibrated by the contractor and they have been maintained and calibrated step by step once they became under the direct management of SEDAPAL. The SCADA system for the pumping facilities is almost 10 years old and its service life has elapsed. There have been many instances of failed radio communication between the facilities and the control room and many facilities can no longer be remotely controlled. Even without the remote control function, however, the pumping facilities do operate automatically, but on-site monitoring by an operator is necessary. The reason why such failure has been left unattended is a technical reason in that this particular SCADA system involves old technologies and the system configuration is very complicated. As some SCADA systems introduced after the Project use equipment of a different manufacturer and the technologies used for the SCADA systems introduced under the Project have become obsolete, the Pumping Operation and Maintenance Team have begun research and examination work to simplify and standardize the entire SCADA system.

No major problems have been observed in regard to the institutional, technical and financial aspects of the operation and maintenance of the Project. Therefore, overall sustainability of the Project effects has been high.

4. Conclusions, Recommendations and Lessons Learned

4.1 Conclusions

The Project was implemented to expand and improve the water supply and sewerage services in marginal areas of the northern LMA by means of constructing a new WTP and improving the water supply and sewer networks, thereby contributing to improvement of the living conditions in these areas. The water supply and sewage management sector has

consistently been a priority development sector for the Government of Peru since the time of appraisal to the time of ex-post evaluation. At the time of appraisal, there was a great need for the development of water supply and sewer systems, and the facilities constructed or improved under the Project play an important role at the time of ex-post evaluation. The Project was relevant to Japan's ODA policy at the time of appraisal. Based on the above, the relevance of the Project is high. Of the planned facilities under the Project, the construction of the Huachipa WTP and the North Branch was implemented after postponement of six years as a result of review of the water demand in the LMA. Meanwhile, the construction work to connect the North Branch to the existing water supply networks is not fully completed at the time of ex-post evaluation due to cancellation of the relevant contract with the contractor. Because of these delays, the project implementation period has more than trebled compared to the plan. The project cost has almost doubled due to price increases and an increased work volume. Therefore, the efficiency of the Project is low. The expansion of water supply and sewerage services following the consolidation of the water supply and sewer systems under the Project have achieved nearly 90% of the original targets. The intended effects of the Project have been generally achieved as planned. These include the expansion and improvement of the water supply and sewerage services and improvement of the living conditions for households with new connections as well as existing connections. The water production volume of the Huachipa WTP, on the other hand, is currently only one-quarter of the planned volume due to the delayed connection work to the existing water supply networks. Therefore, the effectiveness and impact of the Project is fair. As no specific problems are observed with the institutional, technical and financial aspects of the operation and maintenance of the Project, the sustainability of the Project is high.

In conclusion, the Project is evaluated as being partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations for the Implementation Agencies

SEDAPAL should swiftly complete the construction of the relevant general water supply networks for the Huachipa WTP and North Branch under the Project so that these facilities can be fully utilized as soon as possible. SEDAPAL should also conduct an investigation on the damage to the intake of the Huachipa WTP and arrange adequate permanent measures.

4.2.2 Recommendations for JICA

None

4.3 Lessons Learned

Consistency of Water Supply Facility Construction Program

In construction of water supply facilities for large cities, if there is no consistency in the construction program (an overall plan on implementation of multiple construction projects) to develop water source, water production facility and water distribution facilities, there is a possibility of reducing the project effects. Therefore, it is important to ensure sufficient consistency in preparing the construction program including water source, water production and distribution facilities, and also conduct precise progress management to maintain consistency in implementation. If such a construction program contains a project involving donors, it is necessary that the organizations responsible for the improvement of water supply in the city concerned should carry out progress management with due attention to consistency among the projects in close collaboration with the donors. With regard to the Project, while such consistency was ensured within its scope at the planning stage, since the connection works with the secondary networks through the Project as well as other related projects were delayed compared with the completion of the Huachipa WTP and the North Branch, the water production volume remained at a quarter of the planned amount and sufficient effectiveness and impact were not obtained.

Comparison between Plan and Actual Achievement

Item	Plan	Actual Achievement
① Outputs		
Huachipa Water Treatment Plant		
Intake facilities:		
Intake weir	10m^3/sec	As planned
Conveyance pipeline	5m^3/sec	As planned
Water treatment plant:		
Treatment capacity	5m^3/sec	As planned
North Branch		
Transmission pipelines (length)	26.4km	As planned
Distribution reservoir (distribution tank)	5 sites	4 sites
General water supply and sewer networks		
Water Supply Service:		
Construction of well	6 sites	0 sites
Improvement of well	42 sites	61 sites
Construction of distribution tank	75 sites	64 sites
Improvement of distribution tank	38 sites	91 sites
Laying of distribution pipes	174.0km	134.9km
Sewerage Service:		
Sewer pipelines	19.9km	51.7km
Secondary water supply and sewer networks		
Number of new water supply connections	52,000	43,836
Number of new sewer connections	47,000	43,760
② Project Period	March, 2000 - September, 2005 (67 months)	March, 2000 - November, 2016 (Not yet completed, 201months)
③ Project Cost		
ODA loan	23,854 million yen	34,094 million yen
Funding by Peru	8,284 million yen	24,132 million yen
Total	33,138 million yen	58,227 million yen
Conversion rate	1 US$ = 113.5 yen	1 US$= 101.0 yen