# Ex-Post Project Evaluation 2013: Package II-1 (Costa Rica, Mexico, Brazil)

**January 2015**


## JAPAN INTERNATIONAL COOPERATION AGENCY

**ICNET CO.LTD.**


| |
|---|
| EV |
| JR |
| 14-23 |

# Preface

Ex-post evaluation of ODA projects has been in place since 1975 and since then the coverage of evaluation has expanded. Japan's ODA charter revised in 2003 shows Japan's commitment to ODA evaluation, clearly stating under the section "Enhancement of Evaluation" that in order to measure, analyze and objectively evaluate the outcome of ODA, third-party evaluations conducted by experts will be enhanced.

This volume shows the results of the ex-post evaluation of ODA Loan projects that were mainly completed in fiscal year 2011, and Technical Cooperation projects and Grant Aid projects, most of which project cost exceeds 1 billion JPY, that were mainly completed in fiscal year 2010. The ex-post evaluation was entrusted to external evaluators to ensure objective analysis of the projects' effects and to draw lessons and recommendations to be utilized in similar projects.

The lessons and recommendations drawn from these evaluations will be shared with JICA's stakeholders in order to improve the quality of ODA projects.

Lastly, deep appreciation is given to those who have cooperated and supported the creation of this volume of evaluations.

January 2015

Toshitsugu Uesawa
Vice President
Japan International Cooperation Agency (JICA)

Disclaimer

This volume of evaluations, the English translation of the original Japanese version, shows the result of objective ex-post evaluations made by external evaluators. The views and recommendations herein do not necessarily reflect the official views and opinions of JICA. JICA is not responsible for the accuracy of English translation, and the Japanese version shall prevail in the event of any inconsistency with the English version.

Minor amendments may be made when the contents of this volume is posted on JICA's website.

JICA's comments may be added at the end of each report when the views held by the operations departments do not match those of the external evaluator.

No part of this report may be copied or reprinted without the consent of JICA.

Republic of Costa Rica

Ex-Post Evaluation of Japanese ODA Loan

Pirris Hydroelectric Power Development Project

External Evaluator: Hiromi Suzuki S., IC Net Limited

## 0. Summary

The project aimed to improve the stability of electric supply capacity in Costa Rica by constructing a hydroelectric power plant in the middle stretches of the Pirris River which runs through the central plateau of the country.

The project was in line with Costa Rica's national development plans, development needs and Japan's assistance policies, both at the time of the appraisal and at the time of the ex-post evaluation. Therefore its relevance is high. The main indicators which reflect the effects of the Pirris Hydroelectric Power Plant (PHPP) have either mostly achieved its targets or are improving. In addition, in a country where hydroelectric power generation is the base load, the project has not only strengthened the hydroelectric generation capacity, but it has also contributed to a more stable electric supply capacity as well as to solving future electricity supply-demand gaps. These effects can be recognized as the PHPP is connected to the National Electricity System (SEN), through the Parrita-Lindora transmission line (230kV, 118km)[1] which was constructed as a separate project of the Executing Agency. Based on the above, the project effectiveness is evaluated to be satisfactory. In addition, other positive impacts were observed such as afforestation activities and effects from the construction of access roads, among others, thus the project's level of achievement of its intended effects and impacts is high. The efficiency of the project is evaluated to be low, because both project period and project cost significantly exceeded the plan. With regard to the sustainability of the effects of the project, no major problems have been observed in the institutional, technical and financial aspect of operation and maintenance, therefore sustainability of the project effect is high.

In light of the above, this project is evaluated to be satisfactory.

## 1. Project Description


Project Location

Pirris Hydroelectric Power Plant RCC[2] Dam
(provided by Costa Rican Institute of Electricity, ICE)

[1] From the time of appraisal, the construction of the Parrita-Lindora transmission line was a precondition for the realization of the effects of the project.

[2] RCC (Rolled Compacted Concrete) is an extremely stiff consistency concrete with less amount of cement. Because it is possible to place large amounts of concrete at once, it has the advantages of shorter construction periods and less construction costs, characteristics that make it a reasonable construction method (Reference: Website of the Japan Concrete Institute and the Japan Dam Foundation).

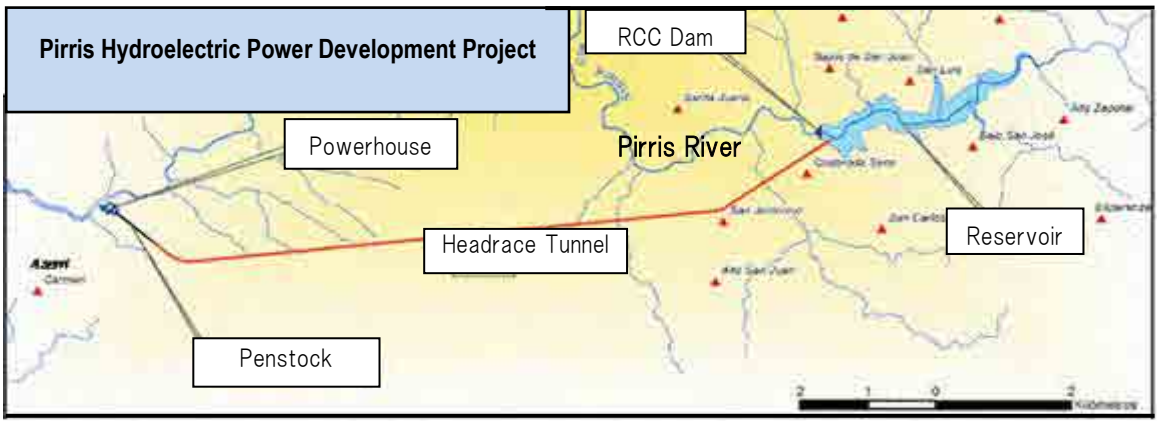
### 1.1 Background[3]

Costa Rica was one of the most politically stable countries in Central America, and it was achieving a high economic growth especially under the "National Development Plan 1994-1998", which attracted high-tech industries and increased exports based on the establishment of tax-free processing zones. On the other hand, in order to continue with the National Development Plan and to maintain a sustainable economic growth, it was imperative to develop economic and social infrastructure including power sources. Especially in regard to electricity demand, it was increasing year by year as the economy grew, and it was estimated to continue increasing by an annual rate of 5.7% until 2020. Thus there was a pressing need to improve the reliability of a stable electric power supply.

Electricity in Costa Rica was supplied mainly by the Costa Rican Institute of Electricity (ICE), who was developing electric power sources by utilizing the country's water and geothermal resources. In particular, hydroelectric power generation accounted for three-quarters of the total electric power supply and was considered to be the country's base load. In 2001, the country did maintain the necessary power generation infrastructure to cover the power demand, but it would soon become difficult to fill the electricity demand-supply gap which was estimated to occur from 2006 onwards, thus it was urgent to take specific actions.

### 1.2 Project Outline

The objective of this project is to improve the stability of electric supply capacity in Costa Rica by constructing a hydroelectric power plant with a 128MW generation capacity in the middle stretches of the Pirris River which runs through the central plateau, located 70km to the south of San Jose, the capital of the country, thereby contributing to solving the future electricity demand-supply gap and to improving the hydroelectric power generation capacity which is the base load of the country.




Source: ICE

Figure 1: Pirris Hydroelectric Power Development Project

[3] Based on JICA's appraisal documents and press releases.

| | |
|---|---|
| Loan Approved Amount/ Disbursed Amount | 16,683 million yen / 16,402 million yen |
| Exchange of Notes Date/ Loan Agreement Signing Date | April 2001 / April 2001 |
| Terms and Conditions | Interest Rate: 2.2%<br>Repayment Period: 25 years<br>(Grace Period: 7 years)<br>Conditions for Procurement: General Untied |
| Borrower / Executing Agency | Instituto Costarricense de Electricidad (ICE) |
| Final Disbursement Date | October 2011 |
| Main Contractors (Over 1 billion yen) | Holcim (Costa Rica) / Toxement (Costa Rica) (JV), Astaldi Spa. (Italy), Andritz Hydro Gmbh (Austria) |
| Main Consultant (Over 1 million yen) | Electric Power Development Co., Ltd. (Japan) |
| Feasibility Studies, etc. | 1992: "Pirris Hydroelectric Power Development Study Plan" (JICA)<br>1998: "Pirris Hydroelectric Power Basic Design Plan" (ICE) |
| Related Projects | [Japanese ODA Loan]<br>"Miravalles Geothermal Power" (Completed in March 1994); "Geothermal Sector Loan Enforcement Promotion Project in Costa Rica" (Loan Agreement: August 2014)<br>[Other Donors' Projects]<br>Inter-American Development Bank "Angostura Hydroelectric Project" (Completed in October 2000) |

## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Hiromi SUZUKI S. (IC Net Limited)

### 2.2 Duration of Evaluation Study

Duration of the Study: September 2013-November 2014

Duration of the Field Study: November 24- 29, 2013 and April 20-23, 2014

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

### 3.1 Relevance (Rating: ③[5])

3.1.1 Relevance to the Development Plan of Costa Rica

3.1.1.1 Relevance to the Development Plan at the Time of Appraisal

The development plan at the time of the appraisal was the "National Development Plan (1998-2002)" formulated by the Ministry of National Panning and Economic Policy (MIDEPLAN). Development of social infrastructure, including electric power, improvement of public services, and sustainable utilization of natural resources were among the 15 development objectives of the said Plan. With regard to the electric power sector, in order to respond to the growing electricity demand, which was estimated to increase steadily, the Ministry of Energy (MINAE) formulated the "Third National Energy Plan (2000-2020)". The Plan required that ICE, which was the entity in charge for electric power supply in Costa Rica[6], formulate a concrete Electric Power Development Plan, so as to fill the future demand-supply gap. Based on these Plans, ICE formulated the "Electric Power Development Plan (2012-2024)" which planned to construct 29 electric power plants by 2020, in order to fill the above-mentioned demand-supply gap. Specifically, this project (Pirris Hydroelectric Power Plant, 128MW) was the second largest project after the Angostura Hydropower Plant (Starting of operations: 2000, 177MW) and it was considered as one of the most important national projects.

3.1.1.2 Relevance to the Development Plan at the Time of Ex-Post Evaluation

The development plan at the time of the ex-post evaluation was the "National Development Plan 2010-2014". In the energy sector, its purpose is to "protect the environment and achieve sustainable development", and seeks also to achieve "Carbon neutrality" which offsets greenhouse gas emissions with absorptions by 2021 through the development of clean energy sources such as hydro and geothermal power. Based on the said National Development Plan, MINAE formulated the "Sixth National Energy Plan (2012-2030)" in which electricity demand is expected to continue growing as a result of Costa Rica's economic growth estimations and improvement in the living of standards of its people. In order to cope with this growth, the said Plan targets the development of renewable, low-cost energy sources; restrain negative effects to the environment as much as possible; and improve health and living standards of the people of Costa Rica. ICE formulated the "Electric Power Development Plan (2012-2024)" based on the above plans, in which aims to secure a stable electricity supply, reduce dependence to fossil fuels and reduce greenhouse gas emissions. In addition, while hydroelectric

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

[5] ③: High, ②: Fair, ①: Low

[6] Costa Rica's electricity sector is called "National Electric System (SEN)". Companies engaged on power generation, besides ICE, who accounts for 70% of the total power generation capacity, are CNFL -an ICE subsidiary-, Rural Electrification Cooperatives (four), Public Electric Companies (two), and a private company. ICE is the only company engaged in transmission, and companies engaged in distribution are ICE, CNFL, Rural Electrification Cooperatives (four) and Public Electric Companies (two).

power generation continues to be the country's base load, it also seeks to achieve the ideal balance between hydro, wind, and geothermal energy[7].

As stated above, both at the time of appraisal and the ex-post evaluation, Costa Rica's National Development Plans, National Energy Plans, and ICE's Electric Power Development Plans consider filling the electricity demand-supply gap and achieving a stable supply of electric power as their development objectives. It also continues to put emphasis on renewable energies including hydroelectricity -which utilizes the country's own natural resources- to achieve these goals. In this sense, the project is highly relevant to Costa Rica's development policies both at the time of appraisal and the ex-post evaluation.

3.1.2 Relevance to the Development Needs of Costa Rica

3.1.2.1. Development Needs at the Time of Appraisal

At the time of appraisal, electricity demand in Costa Rica was growing year by year. Actual electricity demand grew by an annual average of 5.5% between 1985 and 1997, and by 6.5% between 1998 and 2000. Furthermore, electricity demand was expected to grow by 2020 at an annual average rate of 5.7%, mostly due to the advance of high-tech industries into the country. On the other hand, according to the construction plans of new power generation plants and renovation of existing obsolete power plants that existed at the time, it was estimated that after 2006, it would not be possible to secure a stable electric power supply. In addition, with ICE's limited budget, it was deemed difficult to construct the 29 power generation plants that were planned to be completed by 2020 according to the Electric Power Development Plan, and to simultaneously conduct the necessary construction of transmission facilities in a prompt manner. Thus it was necessary to take urgent measures to secure a stable supply of electricity.

ICE's power generation capacity by the end of 2000 was 1,470MW (hydro 1,098MW (75%), thermal 234MW (16%), geothermal 137MW (9%)), and electric power generation capacity (MW) was above electricity demand. However, Costa Rica has a tropical wet and dry climate in which there is a serious lack of water during the months of December to April, which is the dry season. Because the energy source for hydroelectric power generation drops dramatically during this period, there was a risk of a serious demand-supply gap during the peak periods of the dry season (February to April), which could cause a decrease in the reliability of a stable electric power supply. Although the lack of capacity in electric power supply was served by thermal power generation, Costa Rica does not have fuel for thermal power generation, making it necessary to rely on imports. However, an over-dependence on thermal power generation was not in line with the country's development plans. Therefore, if measures were not taken, there was a risk of an increased dependence on fuel imports from 2007, which was a major concern for ICE. Under these circumstances, the need to develop a hydroelectric power plant with a dam that utilizes national water resources was extremely high in

[7] At the time of the ex post evaluation, among the power generation plants that ICE was putting emphasis on, were included the hydroelectric power plants of Reventazón (292 MW), Diquis (623 MW), Tacares (7MW), and Savegre (160MW).

order to both increase the county's electric power supply capacity and improve the stability of such capacity[8].

3.1.2.2. Development Needs at the Time of Evaluation

Costa Rica's electricity demand grew at an annual average rate of 2.9% from 2009 to 2012, which was not as high as it was expected at the time of appraisal, mainly due to the global financial crisis which was caused by the 2008 Lehman Shock, but is on a stable upward trend. According to the most recent electricity demand estimations announced in 2011 by the National Energy Planning Center (CENPE), the entity that makes such estimations, the annual average electricity demand growth rate by 2024 will be 4% and the estimated demand is 18,148GWh. As can be seen, the development need of securing a stable power supply for the future continues to exist. ICE's power generation capacity in 2011 was 2,590MW, which was more than the electricity demand of 1,598MW. However, the marginal supply capability[9] was 7%, failing to achieve the criteria of 8%-10% that secures a stable electric power supply, making it necessary to continue strengthening such capacity. Based on CENPE's demand estimates, in its "Electric Power Generation Plan (2012-2024), ICE is planning to increase the participation of hydropower generation capacity from 65% to 72% as shown in the table below, thereby increasing the total power generation capacity to 4,304MW by 2024, corresponding to an estimated demand of 2,962MW.

Table 1: Electricity power demand, supply and power generation capacity in Costa Rica

| | | 2011 Actual | | 2024 Estimation / Plan | |
|---|---|---|---|---|---|
| Electricity demand | | 1,598MW | | 2,962MW | |
| Total Power Generation Capacity | | 2,590MW | 100% | 4,304MW | 100% |
| | Hydro | 1,691 MW | 65% | 3,099MW | 72% |
| | Wind | 129 MW | 5% | 301MW | 7% |
| | Geothermal/Biomass | 234 MW | 9% | 344MW | 8% |
| | Thermal | 537 MW | 21% | 560MW | 13% |

Source: CENPE (2011) "Electricity Demand 2011-2033" and ICE "Electric Power Development Plan (2012-2024)"

As stated above, electricity demand continues to grow in Costa Rica and the development need to strengthen power generation by using water, which is one of its natural resources in order to secure a stable electric supply capacity can be recognized at the moment of the ex-post evaluation as well.

3.1.3 Relevance to Japan's ODA Policy

Japan's assistance policy towards Costa Rica was not formulated at the time of appraisal.

[8] Besides this project, ICE has conducted the "Miravalles Geothermal Power Plant Development Project" (Japanese ODA loan project, completed in March 1994, 55MW) and the Inter-American Development Band funded "Angostura Hydroelectric Project" (starting operations in October 2000, 177MW), actively promoting the development of renewable power sources that would not depend on imported resources.

[9] The marginal supply capability is an indicator that shows the excess supply capacity against electricity demand. [(Peak supply capacity – estimated maximum demand) / estimated maximum demand] x 100. Ordinary, it is considered to be from 8% to 10% (Reference: Website of the Ministry of Economy).

Therefore, for the ex-post evaluation, the consistency of the project was checked with JICA's "Medium-Term Strategy for Overseas Economic Cooperation Operations (1999-2002)", which was formulated based on the basic strategies and policies of Japan's Official Development Assistance (ODA). The said Strategy's main objective is to reduce poverty in developing countries. It also aims to achieve a sustainable economic growth through the development of economic and social infrastructure and creation of industries; and to support a fair distribution of the fruits of economic development through poverty alleviation and social development measures. Based on these objectives, it established six focus areas that included strengthening of infrastructure for production and environmental protection measures. With regards to assistance strategies towards Central and South America, it focused on the development of infrastructure for the alleviation of income disparities as well as regional disparities. It also planned to actively assist projects that would contribute to the preservation of regional environment, as well as projects that were aiming to solve global environmental problems. In light of the above, the project is consistent with the Japanese Government assistance sectorial strategy as well as with the assistance strategy towards Central and South America[10].

This project has been highly relevant with the development plans and development needs of Costa Rica, as well as Japan's ODA policy. Therefore its relevance is high.

### 3.2 Effectiveness[11] (Rating: ③)

#### 3.2.1 Quantitative Effects (Operation and Effect Indicators)

With respect to the project's operation indicators, evaluation was conducted based on the indicators for which targets were set at the time of appraisal, as well as indicators that are used as main indicators by ICE that have internally set targets. The target year is 2013 which is two years after the project was concluded. In the table below, actual data and their target achievement levels for 2011 and 2012 are also indicated for reference. In order to conduct the evaluation of the project's operation and effect indicators, it is necessary to consider the role that the PHPP plays in Costa Rica's SEN. Hydroelectric power plants have some advantages over other plants such as the ability to operate not only during dry season, and to quickly respond when sudden increases in electricity demand occur. In addition, time necessary to restart the plant after stopping operations is only a few minutes compared to thermal power plants[12], which enables hydroelectric power plants to immediately supply electricity in case of an emergency[13].

All four operation indicators have either achieved more than 80% of the target, or have achieved

[10] With the objective of contributing to Costa Rica's sustainable growth by increasing electric supply capacity, as well as by easing climate change effects through the promotion of renewable energy, the Loan Agreement of the "Guanacaste Geothermal Development Sector Loan" (ODA loan amount 16,810 million yen) was signed on August 18, 2014 between the Government of Japan and the Government of Costa Rica.

[11] Sub-rating for Effectiveness is to be put with consideration to impact.

[12] Thermal generation plants require from more than 15 minutes to few hours to restart operations.

[13] According to ICE, when PHPP is compared with other hydroelectric plants in Costa Rica, PHPP has the following two characteristics that strengthen its backup role: (1) Pelton turbines that make it especially easy to start and stop operations and can automatically adjust to changes in voltage, and (2) emergency power generators that enable it to restart operations in case of emergency, without having to depend on other power plants.

the target in 2013, which is two years after the project was completed. As mentioned above, when the backup role for electric power supply capacity is taken into consideration, the "Operability Factor" which indicates the probability of the power plant to be in a state that can be operated, as well as the "Reliability Factor" which indicates the probability that a power plant does not fall into a forced outage condition, are important indicators. In this project, both indicators have achieved their targets. Since periodical inspections are conducted properly, non-planned outage hours have improved to less than a quarter of the target.

Table 2: Operation and Effect Indicators

| Name of Indicator | Target Value Two years after project completion | Actual Value (Target achievement levels are indicated within parenthesis) | | |
|---|---|---|---|---|
| | | 2011 Project completion year | 2012 (One year after project completion) | 2013 (Two years after project completion) |
| Operation Indicators | | | | |
| 1. Operability Factor[1] | ICE Target 100% | — | 94.6% More than 80% of target | 92.8% More than 80% of target |
| 2. Reliability Factor[1] | ICE Target 100% | | 99.5% More than 80% of target | 99.6% More than 80% of target |
| 3. Hydro Utilization Factor[2] | 90% | 80% (Aug. to Dec.) (88%) More than 80% of target | 89% (99%) Target almost achieved | 84% (93%) More than 80% of target |
| 4. Non-planned Outage Hours[3] (Due to mechanical problems) | Annual Total Maximum: 175 hours | 118.2 (Improved to 65% of target) Target Achieved | 195.4 (Over 20 hours of target) Target Not Achieved | 42.0 (Improved to 24% of target) Target Achieved |
| 5. Planned Outage Hours[4] | Reference: 525 hours /year | 609.6 | 759.9 | 1,219.7 |
| Effect Indicators | | | | |
| 6. Net Electric Energy Production (GWh/year) | 571 | 312.5 (55%) Target Not Achieved | 499.2 (87%) More than 80% of target | 446.2 (78%) Target Not Achieved |
| <Reference Indicators> Annual Total Volume of Inflow to the Reservoir (million $m^3$/year) | 310.3[5] | 144.7 (47%) | 231.1 (74%) | 158.3 (51%) |
| 7. National Electricity Consumption[6] (MWh) | Preferable to be in an upward trend | 8,601,761 | 8,914,576 | 9,006,031 |
| 8. Electrification Rate (%) | More than 94.8% (Actual for 2000) | 99.3% More than reference value | 99.4% More than reference value | 99.4% More than reference value |

Source: JICA Appraisal documents, ICE.

1: "Operability Factor (probability that a plant is in operable conditions throughout a year, based on actual operation records)" and "Reliability Factor (probability that a plant does not suffer forced outages throughout a year)" are indicators used commonly by ICE as operation indicators. Since a hydroelectric power plant that is linked to the national system plays the role as a backup plant as well, these indicators were considered relevant to be included in the evaluation as quantitative indicators.

2: Hydro Utilization Factor is based on ICE's definition. Hydro Utilization Factor = (Annual Volume of Electricity Generation (GWh) ÷Annual Potential Volume of Electricity Generation (GWh)) x100. Where "Annual Potential Volume of Electricity Generation" is the sum of the values of the "Weekly Potential Volume of Electricity Generation" for 52 weeks; and Weekly Potential Volume of Electricity Generation (GWh) = [weekly average inflow ($m^3$/s) x power generation factor (7.4932MW/($m^3$/s))x168 hours÷1000]

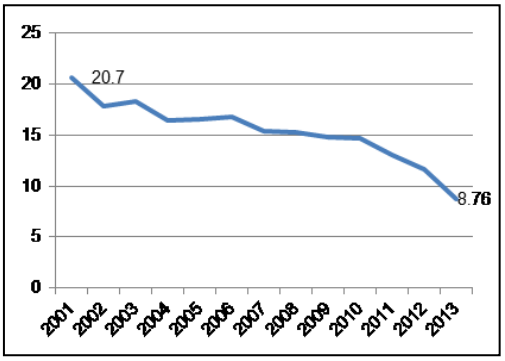
3: Non-planned outages can be caused by (1) machine failure, (2) human error, and (3) natural disasters, among others. There were no non-planned outages caused by (2) and (3), thus the total value indicated in the table is due totally to machine failure.

4: Reference indicator. Non-achievement of the target does not necessarily result in a low evaluation.

5: Estimation of the annual total volume of inflow to the reservoir used in the Detailed Design.

6: Reference indicator. There is no target value set, as it is not appropriate to do so separately from the value of the demand forecasted within the Electric Development Plan.

Annual planned outage hours were verified as an indicator that reflects the improvement in the stability of electric supply capacity. While in 2001 the value was 20.7 hours, in 2013 it decreased considerably to 8.76 hours. Compared to the time of appraisal, it can be seen that stability of electric supply in the national system has absolutely improved (Figure 2).




Source: ICE

Figure 2: Annual planned outage hours

With respect to the effect indicators, the only one for which a target was set at the time of appraisal was the Net Electric Energy Production, which has failed to meet the target from 2011 to 2013. The main reason is that due to the reduction in rainfall seen in recent years, the Annual Total Volume of Inflow to the Reservoir has significantly decreased respectively to 47%, 74% and 51% of the Annual Total Volume of Inflow to the Reservoir estimated in the Detailed Design (310.3 million $m^3$/year). National amount of electricity consumption is on an upward trend, and Electrification Rate has considerably increased from 94.8%, which was the reference value for the year 2000, to 99.4% in 2013.

From the above, among the six indicators for which either target values or reference values were set, the only indicator that did not achieve its target in 2013 was the Net Electric Energy Production. The rest of the indicators have either achieved more than 80% of the target or have achieved the target, thus quantitative effects of the project can clearly be recognized.

3.2.2 Qualitative Effects

The qualitative effects of the project expected at the time of appraisal can be considered as effects at the project impact level, and thus these were analyzed under “Section 3.3 Impact”.

**3.3 Impact**

3.3.1 Intended Impacts

The expected impacts of the project were: improving hydroelectric power generation capacity, filling the future demand-supply gap, improving investment environment as well as increasing the potential for economic development, through the construction of the power plant.

3.3.1.1 Improving Costa Rica’s hydropower generation capacity and filling the future demand-supply gap

As mentioned above, according to CENPE’s most recent demand estimation, electricity demand will grow at an annual average rate of 4% by 2024, and estimated amount of electricity demand will be 18,148 GWh, indicating that a stable supply of electricity will continue to be necessary (for details see “3.1.2.2 Development Needs at the Time of the Evaluation”) . Improving ICE’s capacity of hydroelectric power generation, which accounts for 70% of the total power generation capacity as well

as the total volume of electricity generated for Costa Rica's SEN, means a stable supply of electricity for the country. The PHPP, which was completed in 2011, is connected to the national system through the Parrita-Lindora transmission line, and in 2012, it accounted for 5% of SEN's electric generation capacity as well as volume of electricity generated respectively, indicating that the project is clearly contributing to the improvement of hydropower generation capacity, as well as filling the future demand-supply gap.

Table 3: Project's contribution to the National Electricity System

| | 2010 | | 2012 | |
|---|---|---|---|---|
| Power Generation Capacity | | | | |
| | KW | Participation in the SEN (%) | KW | Participation in the SEN (%) |
| Total SEN | 2,605,295 | | 2,723,181 | |
| Total ICE | 1,902,939 | 73% | 2,080,190 | 76% |
| Hydro | 1,119,709 | 43% | 1,258,869 | 46% |
| Pirris HPP | - | - | 140,272 | 5% |
| Thermal | 627,270 | 24% | 612,601 | 22% |
| Geothermal | 136,160 | 5% | 187,910 | 7% |
| Wind | 19,800 | 1% | 19,800 | 1% |
| Solar Power | - | | 1,010 | 0.04% |
| Electric Power Generated | | | | |
| | MWh | Participation in the SEN (%) | MWh | Participation in the SEN (%) |
| Total SEN | 9,503,002 | | 10,076,344 | |
| Total ICE | 6,655,309 | 70% | 7,459, 250 | 74% |
| Hydro | 5,291,523 | 56% | 5,349,469 | 53% |
| Pirris HPP | - | | 503,653 | 5% |
| Thermal | 335,637 | 4% | 830,284 | 8% |
| Geothermal | 963,837 | 10% | 1,190,398 | 12% |
| Wind | 64,312 | 1% | 79,804 | 1% |
| Solar Power | - | - | 295 | 0.003% |

Source: ICE.

The project's impact is not limited to improving the hydroelectric power generation capacity as mentioned above; it also plays the role of a backup power source during dry season, and during sudden changes in electricity demand. It also contributes to the improvement of the Central Pacific Ocean region's electricity service, as well as the Central American Electrical Interconnection System[14] (SIEPAC), to which it is connected through the Parrita Substation, playing a strategic role in the Central American electricity market. Through the above-mentioned roles, the project is contributing greatly both to the improvement of hydropower generation, which is the base load of Costa Rica, and to the strengthening of the SEN.

3.3.1.2 Improvement in the investment environment and economic development potential of Costa Rica, by improving the stability of electric supply capacity

[14] The Central American Electrical Interconnection System (SIEPAC) is a system that interconnects six Central American countries (Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama) with a 1,793km long transmission line, which enables selling and buying electricity within the region. It is operated by the Network Owner Company (EPR) which was established by the electric utility companies of the six countries.

In order to grasp the project's impact, a survey was conducted to large consumers[15]. Opinions in reference to the stable power supply, importance of electricity as a determinant for investment, and the positive and negative changes brought about by the project were gathered.

1) Stable power supply

All companies have a power contract for medium voltage (34.5KV) or high voltage (230KV, 138KV), thus their power supply is stable, and "power quality (changes in voltage)" is high. With regard to "Stable power supply, 9 out of 10 companies answered that they are "very satisfied or satisfied". The reason one company was not satisfied, was related to electricity rates which will be discussed below, and ICE's response during non-planned outages. With respect to ICE's response during non-planned outages (especially when transmission lines and electric poles are damaged due to hurricanes and/or accidents), nine other companies also mentioned that "even if the outage is short, there are significant damages to the machinery, thus a quick response by ICE is expected". As mentioned above, although the non-planned outage hours have significantly improved, it became clear that a better response when non-planned outages occur is required. On the other hand, with respect to planned outages, all 10 companies responded that "it has improved compared to how it was three years ago" and although it is necessary to coordinate dates and time with ICE, seven out of 10 companies said that these coordination opportunities are a good way to communicate with ICE and build a good relationship with them. At the moment of the ex-post evaluation, companies were using the planned outages as an opportunity to conduct machinery maintenance, and no specific effects or problems such as damages were observed.

2) Importance of electricity and its rates as determinants of investment

Improvement of electricity rates was what all the companies were most hoping for. Nine out of 10 companies do business not only in the domestic market, but use Costa Rica as a production base to export their products to markets in North America, South America and Asia. The companies responded that electricity rates are a major concern, as electricity cost can even reduce their competitiveness. A common opinion was that "in Costa Rica's case, a major determinant for direct investment is its political and economic stability, which is the reason why there are no big fluctuations in direct

[15] Details of the large customers survey is as follows. (1) Survey period: end of November 2013 to mid-January 2014; (2) Number of companies surveyed: ten (six foreign-owned companies); Industry: Food processing (three), dairy (one), aquaculture (one), auto parts (one), electric parts (two), metal processing (one), services (one); (4) number of years operating in Costa Rica: less than 10 years (two), 10 to less than 15 years (one), 15 to less than 20 years (six), 20 years or more (four); (5) percentage of electricity cost in the product's cost price: 10% (one), 15% (one) 17% (two), No response (six); (6) geographical distribution by province: San Jose (three), Alajuela (three); Puntarenas (three) Cartago (one); (7) method of selection: selected from the large consumer list taking into consideration the geographical distribution and industry classification. Originally request to participate in the survey was made to 15 companies, but no cooperation could be obtained from five companies.

investment. But if electricity rates continue to increase, competitiveness will decrease, and foreign companies will be forced to withdraw from the country[16]".

3) Positive and negative changes brought about by the project

With respect to the project, three companies said to "know it very well" and seven said "to have heard of it". From the former three companies, one actually had visited the project. A common opinion among these three companies was that "the project cost was very high; however, it was important and necessary in order to secure a stable power supply and to reduce dependence on fossil fuels in Costa Rica". With respect to social effects, environmental changes and problems related to resettlement and land acquisition brought about by the project, they said "not to have heard of anything in particular".

From the above, among the expected impacts, it was possible to recognize the improvement of Costa Rica's hydroelectric power generation capacity, and filling the future demand-supply gap by improving the stability of power supply as the project's impacts. On the other hand, with respect to the relationship between the project and the investment environment, as well as the improvement of economic development potential, it is difficult to probe a direct causal effect between those and the project to begin with, because the electricity generated by the project is transmitted to the whole country through the SEN. However, large consumers said that "in a before-after comparison, Costa Rica's power supply is more stable and quality of electricity has improved from a general point of view". From this statement it can be said that the project has contributed to strengthen the SEN. In addition, when economic growth rates and Foreign Direct Investment to Costa Rica before and after the project were compared, the former increased from 2.7% in 2008 to 3.6% in 2013, and the latter increased from 2,078 million U.S. dollars in 2008 to 2,682 million U.S. dollars in 201317. These data support the fact that, together with other economic and social infrastructure, this project has contributed to some extent as a determinant to attract investment and improve the potential for economic development.

3.3.2 Other Impacts

3.3.2.1 Impacts on the Natural Environment

In Costa Rica, all projects that can cause a change in the natural and living environment are obliged to conduct an Environmental Impact Assessment (EIA) and obtain an approval from the

[16] According to a survey conducted by the Costa Rica Chamber of Industries, electricity tariffs in the country have increased from an annual average of 0.069 U.S. dollars/kWh in 2003, to 0.196 U.S. dollars/kWh in 2013, resulting in a 284% increase, which is an obstacle in terms of competitiveness and further attraction or foreign direct investment. However, according to the foreign direct investment statistics of the Ministry of Trade (COMEX), although foreign direct investment to Costa Rica, which was 2,078 million U.S. dollars in 2008, fell to 1,346 million U.S. dollars in 2009 due to the global financial crisis, it recovered to 2,682 million U.S. dollars in 2013. Therefore, the direct causal effect of electricity tariffs is not as clear as the industrialists say. In addition, according to announcements by the Economic Commission for Latin America and the Caribbean (ECLAC, 2012), Costa Rica's main foreign direct investment attraction factors are high level of education and skills of its people, and socioeconomic stability, and it points out that electricity tariffs are the lowest in the Central American region. The discussions on electricity tariffs in Costa Rica have been going for a long time, and due to its political factor, it needs to be handled with care. Therefore, large consumers' opinions on electricity tariffs obtained in this ex-post evaluation were considered only as reference information.

[17] Economic growth rates are from the Central Bank of Costa Rica, and foreign direct investment amounts are from COMEX (See footnote 16 for details).

National Environmental Technical Secretariat (SETENA). ICE conducted the project's EIA from 1997 to 1998, and obtained the approval from SETENA in June 1999[18].

In regard to the environmental impact during the execution of the project, three activities were assumed to be conducted, namely, environmental monitoring and measures during construction period, afforestation activities and water quality monitoring.

As mentioned below under "3.5.1 Institutional Aspects of Operation and Maintenance", an Environmental Management Department was established inside the Pirris Hydroelectric Powerhouse Construction Administration Office (PHP), which was the entity in charge of the management of the project. The said Department conducted the environmental monitoring and implemented necessary measures, afforestation activities and water quality monitoring.

1) Environmental monitoring and measures during the construction period

As indicated in the table below, construction works were conducted strictly observing national standards, and efforts to minimize negative impacts to the environment were taken as much as possible. However, especially with respect to vibration, it affected the neighborhood residents' houses (please refer to "3.3.2.2 Land Acquisition and Resettlement" for details).

Table 4: Environmental impact measures and monitoring status during project execution

| | Monitoring contents and measures during construction works |
|---|---|
| Gas Emission | Periodical inspections of vehicles (including contractor vehicles) were conducted at ICE's repair plant. By making car inspection necessary, vehicle's gas emission rules were strictly followed. |
| Waste Disposal Treatment | A "Waste disposal management program" was implemented. Solid wastes were recycled or reused as much as possible within the project or in other ICE projects (approximately 59 tons of waste were recycled between 2009 and 2011). Liquid wastes were treated by using filters. Scrap was partially sold to scrap processors (2,780 tons of scrap was sold between 2009 and 2011). |
| Dust | In highly populated sections, roads were paved with concrete. In other sections and in the construction sites, water was sprinkled frequently, and measures such as cleaning plants covered with dust were also taken. |
| Muddy water | Especially in concrete plants and sites with a lot of drilling (RCC dam, headrace tunnel), sedimentation devices were introduced. Water quality (suspended solids) were monitored at some points of the river and ensured that national standards would be strictly met. |
| Noise | Noise was monitored in neighborhood communities; measures such as coordinating hours to operate machinery were taken, and national standards were strictly followed. Workers were required to use earplugs. |
| Vibration | Vibrations occurred mostly during the drilling works for the headrace tunnel. Status of infrastructure in neighborhood communities was monitored, and effects of vibrations on other infrastructure were reduced by adjusting drilling works. |

2) Afforestation activities

There were some coffee fields in the area of the reservoir which was submerged (about 141ha), but there were neither natural parks nor designated protected forests. Vegetation around the reservoir was

[18] Approved EIA reports were distributed to provincial authorities, and are also available to the public at ICE's reference room.

also poor and almost no wild animals were found. Thus negative effects of the project to the natural environment were assessed to be minimal at the time of project appraisal. However, in large-scale public projects such as this, there are cases where opposition activities by neighborhood residents and NGOs occur. This project was no exception, and especially at the beginning, there were some opposition movements by neighbor residents of the dam site. However, in order to minimize the negative impact of the project to the natural environment, ICE created a plant nursery where young trees were grown for afforestation. Efforts were made in conducting afforestation activities and environmental education in the project area, gaining the understanding of the neighbor residents[19].

3) Water quality monitoring

At the time of appraisal, there was a concern that the waste water from the coffee refineries located upstream of the Pirris River would flow and accumulate in the reservoir, worsening water quality. The EIA especially pointed out the necessity to monitor the concentration of Biochemical Oxygen Demand (BOD)[20]. The reason why BOD concentration is high both at the time of appraisal and the ex-post evaluation is that coffee plantations use a considerable amount of water in their bean refinery process, and the waste water that contains pulp (skin) is discharged without sufficient treatment into the Pirris River. ICE's role in the water quality issue was to monitor water quality since even before starting the project, and to inform SETENA if it did not meet the national standards[21]. Monitoring of water quality during project execution was done by ICE's Environment Management Department, mainly at 14 monitoring points that included the Pirris River and the powerhouse. An average of six to seven points were selected and monitoring was conducted twice a month for 11 water quality indicators[22]. BOD concentration was especially high in January registering levels between 111mg/L to 118 mg/L, when the volume of waste water from the coffee refineries located upstream reached the highest levels; thus not meeting the national standards sometimes. With respect to other water quality indicators, these differed by period, but there were no major issues.

Environmental impact at the moment of the ex-post evaluation was possible to assess through the water quality monitored mainly at the Pirris River, reservoir, and power house. The entity in charge of monitoring water quality is ICE's Department of Hydrology of the Projects and Related Services, who monitors a total of 20 water quality indicators at seven points in reservoir, five at the power house, and four at the Pirris River. Similar to the project execution period, BOD and Chemical Oxygen Demand

[19] With ICE's afforestation activities, approximately a total of 300,000 trees were planted around the dam site, the power house, and neighboring communities from 2002 to 2011.

[20] BOD is the amount of oxygen that is consumed when organic matters in the water go through a biochemical oxidation and decomposition. The bigger the value, the more polluted is the water (Source: Website of the Japan Ministry of the Environment)

[21] In order to conduct water quality monitoring, ICE signed a water quality management agreement with the Ministry of Agriculture and Livestock, which is the relevant authority in matters related to coffee production, the Ministry of Health, and the Ministry of Environment. Water quality monitoring was conducted based on such agreement.

[22] Items that were monitored were temperature, pH, turbidity, dissolved oxygen, BOD, SS (Suspended Solids), COD (Chemical Oxygen Demand), phosphate ion, ammonium nitrogen, nitrate and dissolved solids.

(COD) were high in January[23], however, with the exception of January, water quality meets the national water quality standard classification III to V[24] required for hydro power generation.

Table 5: Water quality after project completion: Reservoir of Pirris Hydroelectric Power Plant (2013)

| | BOD | COD | SS | pH |
|---|---|---|---|---|
| Minimum value | 1.3 mg/L (September) | 30mg/L (July) | 1 mg/L (April) | 6.24 (July) |
| Maximum value | 31 mg/L (January) | 1,044mg/L (January) | 6 mg/L (January) | 7.12 (April) |
| Water Quality Standard | III-IV* | 25 to <50 mg/L | <10 mg/L | 6.0 to 9.0 |
| | | III～V | I | III |

Source: ICE.

Note: BOD, Ammonium Nitrogen and Dissolved Oxygen are given a score from 1 to 5 according to the range. Water quality is then classified into five levels that go from I (not contaminated) to V (seriously contaminated) based on the total points.

In regard to the issue of high BOD levels, just as during the project execution period, the basic role of the Department of Hydrology of the Projects and Related Services is to monitor water quality, and inform SETENA if quality does not meet the levels required for hydroelectricity generation. However, it is worth mentioning that ICE is doing efforts working together with the government (mainly the Ministry of Agriculture and Livestock and MINAE) as well as research institutions, conducting joint research on environmentally friendly coffee production procedures. In addition, PHPP itself conducts maintenance of the reservoir to keep a stable water quality as much as possible. Especially, water intake management is conducted in order to avoid low water levels at the reservoir, and to keep BOD levels within the acceptable range.

3.3.2.2 Land Acquisition and Resettlement

The process of resettlement and land acquisition was conducted based on "Law No. 6313 on Acquisitions, Expropriations and Easements by ICE". The Law establishes that an appraisal of the land and/or construction must be conducted by a third party, and the amount resulting from the appraisal shall be paid in case of land acquisition, while in the case of resettlement, a relocation site of an equal value must be provided to the residents.

The area of land that was planned to be acquired at time of appraisal was 364ha, but the actual area was 398.5ha, 109% compared to the plan. This was because it was necessary to add another camp site for ICE construction workers at the dam site. The land that was subjected to acquisition was mainly those for the powerhouse, switchyard[25] and the coffee plantations of at the reservoir that went under water. A total of 509 people were affected directly and indirectly by the project at the powerhouse and

[23] Although the coffee production period is from November to March, the peak production season is January.

[24] National water quality standards in Costa Rica are stipulated under MINAE Decree No. 33903 MINAE-S. The basic classification is as follows: I=drinking water, II=aquaculture, III=hydropower generation, IV=navigation (can also be used for aquaculture and hydroelectricity generation subject to limitations), V=navigation (can also be used for hydroelectricity generation subject to limitations).

[25] A device that starts or stops (opens and closes) the flow of electricity generated at the power plant to the transmission line, and it helps to stabilize electricity supply.

switchyard sites. As for the coffee plantation land that was submerged in the reservoir, 152 land owners were affected, but besides these land owners, ICE did not know the number of people that might have possibly been affected indirectly such as seasonal workers. With regard to land acquisition[26], especially, negotiations on the compensation amount at the power house were prolonged, causing a delay in the project. However, all procedures were conducted properly based on the aforementioned Law.

In regard to resettlement, the planned number of households to be resettled at the time of appraisal was a total of 18, that is, seven at the reservoir and its preservation area, and 11 at the access road areas. In case of the latter, resettlement became unnecessary due to a change in route of the access road. Thus, a total of eight households, the original seven plus an additional household, located at the reservoir and its preservation area were resettled (73% compared to plan). From these eight households, two had already been resettled at the time of appraisal. For five out of the remaining six households, the risk of a landslide at the original residential area had already been recognized before the beginning of construction works, but the risk increased with the vibrations of the civil works, thus their resettlement was imperative. The household that was added was outside the landslide risk area at the time of appraisal, but it was included after starting of civil works, as the landslide risk due to vibrations was recognized. The six households that were resettled after the project started were done so based on the aforementioned Law No. 6313, and a relocation place of the same value as the appraisal value was secured at Santa Marta de Tarrazu, as requested by the residents, and their relocation was completed without problems.

#### 3.3.2.3 Other Impacts

Besides the above mentioned expected impacts, the following positive impacts can be recognized in this project[27].

1) Access roads

145km of roads were constructed by the project (including roads for the transportation of materials and equipment). These roads were not only paved with asphalt, but sidewalks, road guards, road signs, bus stops, pedestrian bridges, side ditches and electric poles were installed as well. Some roads to the powerhouse and the reservoir, were checked at the moment of the site inspection, and based on hearings to local residents, socioeconomic effects (for example, transportation safety improvement due to construction of roads, increase in land and real estate prices, increase in number of tourists etc.) to neighboring villages could be recognized.

[26] Average amount of compensation paid for the whole project was 387 colon/$m^2$.
[27] A beneficiary study for residents was not included in the scope of this ex-post evaluation; thus, socioeconomic effects on the living standards of the residents were assessed based on interviews.

2) Effects on cultural assets

At the moment of appraisal, some archeological remains were found at the planned site of the reservoir. ICE conducted a survey during the project, and a burial place of 224m$^2$ was discovered. However, it was concluded that the density of the archeological remains per square meter was low and a permission to continue with the civil works was obtained from the National Institute of Cultural Heritage. A total of 2,120 pieces of pottery were collected from the burial site and all of them were handed to the National Museum. In addition, although on a small scale, an exhibition room has been installed next to the reservoir where explanations on the historical background of the burial site and replicas of the discovered pottery are on display. The excavation site has also been replicated and it is open to the general public. As can be seen, ICE has conducted activities to protect cultural properties as well as educational and public relation activities, based on which it can be judged that negative impacts to cultural properties have been kept at the minimum.

Figure 3: Replica of the burial site next to the reservoir

3) Other socio-environmental activities

In order to reduce impacts to the neighboring communities' living environment and to the natural environment, ICE implemented the "Project for Community Infrastructure and Environmental Protection" separately with its own funds. A total 131 projects (construction of parks, restoration of churches, provision of equipment for the construction of health care centers, and repair of water tanks) at 54 communities were conducted.

As can be seen, ICE separately implemented measures to minimize any negative impacts that could arise from the construction of the project, and positive impacts that were not expected can be recognized.

In light of the above, this project has largely achieved its objectives, therefore its effectiveness is high.

**3.4 Efficiency (Rating: ①)**

3.4.1 Project Outputs

Changes in output occurred mainly with the civil works, but electric equipment and facilities were conducted almost as planned (for details see annex "Comparison of the Original and Actual Scope of the Project").

With respect to civil works, there were changes in all items except quarries and tailrace. Because the geological features of the site where the dam was planned to be constructed were not assessed

accurately in ICE's the geological surveys conducted during the 1998 Feasibility Study (F/S)[28] and the Detailed Design, problems with the soil were found after the civil works had started, thus making it necessary to partially change the design of the dam and to do more excavation works as well as foundation work than what was originally planned. The geological survey issue also happened in the building of the power house. Once civil works had started, it was found that the foundation of the ground of the planned construction site was weak. Thus, the design of the power house building was changed from a ground level type to a semi-underground level type. Taking the results of the 1998 F/S, JICA conducted a survey in 1999 previous to the appraisal, in which it advised[29] ICE to improve the accuracy of the geological survey of the dam site. Taking into consideration the 1992 F/S up to the 1998 F/S, at least three geological surveys were conducted related to this project's dam site, and even after construction started, more geological issues were found which caused considerable changes that affected the project cost and project period (refer to "3.4.2 Project Inputs").

Figure 4: Reservoir

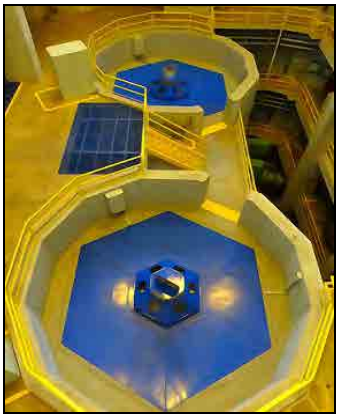


Figure 5: Generator

Other major changes in civil work were the increase in the length of access roads for civil works (207% compared to plan) and the number of camp sites (133% compared to plan). As for the former, routes of these roads were changed in such a way that these were laid avoiding villages in order to minimize project impacts to neighboring residents. As for the latter, an additional camp especially for

[28] In this project, two F/S were conducted: one in 1992 and another one in1998. The 1992 F/S was carried out with JICA funds while the 1998 F/S was carried out by ICE with its own funds. In the 1992 F/S, two candidate sites for the construction of the dam were surveyed: one upstream and one downstream. The conclusion was that although both sites were appropriate, the downstream site was more economical. However, it recommended that additional surveys were necessary for the following: (1) topographical survey, (2) geological survey, (3) material testing, and (4) hydrological measurement. Thereafter, from 1993 to 1996, ICE conducted the above mentioned surveys with its own funds and the results were summarized in 1997 in the document "Results of Additional Surveys". In this Survey's hydrogeological evaluation, it was found that the ground of the downstream dam site -the main candidate- was too weak, so the dam was decided to be constructed in the upstream candidate site, and so, in 1998, ICE carried out the F/S at the upstream site with its own funds. In 1999, JICA advised ICE to improve some technical aspects, and in June 2000 it again advised ICE to improve the accuracy of the geological survey. ICE then submitted the countermeasures (measures that it will take in the Detailed Design and the Construction Planning) to the two aspects advised by JICA, who in turn sent an appraisal mission in August 2000 in order to confirm the technical relevance of these countermeasures. When the mission was dispatched, an agreement was reached between JICA and ICE in reference to the project design, construction, employment of a consultant, schedule, costs, urgency of the project and measures to be taken from thereon, which then led to the signing of the loan agreement in 2001.

[29] JICA internal documents.

ICE construction workers (approximately 200 workers) had to be constructed at the dam site, as halfway of the RCC dam construction, ICE had to take over the work from the contractor Astaldi[30].

### 3.4.2 Project Inputs

#### 3.4.2.1 Project Cost

The planned project cost was 29,443 million yen (foreign currency portion: 15,144 million yen, domestic currency portion: 14,299 million yen), out of which 11,383 million yen from the foreign currency portion and 5,300 million yen from the domestic currency portion were subject to the Japanese ODA loan. The actual project cost was 79,056 million yen, out of which 16,402 million yen[31] was subject to the Japanese ODA loan. The project cost was 269% of the planned cost, significantly higher than planned.

Table 6: Details of the Project Cost

| Item | Planned (million yen) | | | Actual (million yen) | | | % change against plan |
|---|---|---|---|---|---|---|---|
| | ODA loan | Others | Total | ODA loan | Others | Total | |
| Civil Works | 5,333 | 4,039 | 9,372 | 10,124 | 34,675 | 44,799 | 478% |
| Electric machinery and Equipment | 8,973 | 3,411 | 12,384 | 6,030 | 5,719 | 11,749 | 95% |
| Land Acquisition | 0 | 611 | 611 | 0 | 491 | 491 | 80% |
| Administrative Cost | 0 | 2,602 | 2,602 | 0 | 10,349 | 10,349 | 398% |
| Price Escalation | 493 | 130 | 623 | 0 | 0 | 0 | 0 |
| Physical Contingencies | 1,092 | 977 | 2,069 | 0 | 0 | 0 | 0 |
| Consulting Services | 791 | 0 | 791 | 248 | 0 | 248 | 31% |
| Interest During Construction | 0 | 990 | 990 | 0 | 11,419 | 11,419 | 1,153% |
| Total | 16,683 | 12,760 | 29,443 | 16,402 | 62,654* | 79,056 | 269% |

Source: JICA appraisal documents, ICE.
*: ICE's own resources accounted for 42,729 million yen of the 62,654 million yen of the "Other" financial resources, and 19,924 million yen were borrowed from the Central American Bank for Economic Integration.
<Planned values> Exchange rate 1 U.S. dollar=108.36 yen / 1Costa Rican colon=0.3506 yen / Price escalation rates: foreign currency 0.8%, domestic currency: 0.7% / Physical contingency rates: above ground civil works 10%, underground civil works: 15%, electrical machinery and equipment: 5% / Cost calculation reference period: November 2000.
<Actual Values> Exchange rate was calculated by the executing agency using annual exchange rates.

The major change in the total project cost was civil works (478% of the planned cost). Electric machinery and equipment, as well as land acquisition were more than planned in terms of U.S. dollars,

[30] Civil works of the dam were subcontracted to Astaldi; however, because the 2008 tropical storm Alma caused considerable damages in the dam site, the company stopped working for 84 days. As the work interruption period was prolonged, originally, ICE was planning to demand Astaldi to terminate the contract and conduct a new bidding. However, taking into consideration the time required for a new bidding process, it decided to withdraw the demand and avoided further delays in the construction period. Specifically, in 2009 a clause was added to the contract with Astaldi, which indicated that ICE would take over the responsibility of the construction of the RCC dam, spillway and installation of electrical machinery and equipment. As a result, out of the components of the civil works, ICE took charge of the preparatory works, river improvement, headrace tunnel, power house and switchyard, grouting of the dam site, RCC dam, spillway, and installation of electrical machinery and equipment. Grouting of the dam site was assisted by the consultant and a specialist in RCC dams.

[31] According to ICE, the actual amounts are all recorded in U.S. dollars, and are not classified into "foreign and domestic currency". Planned amounts were calculated by the evaluator using the exchange rate indicated in Table 6.

but were within planned in terms of yen due to a strong yen. The reasons for the major change in civil works were modifications in the Detailed Design of the dam after a problem in the ground at the construction site was found once civil work had already started; subsequent changes in excavation and ground work which exceeded the plan; and additional costs due to delay in the construction period. The fact that ICE took over the RCC dam construction from Astaldi, and delays in the construction period also significantly affected the project cost by increasing administrative costs by 398% compared to planned. In addition, the project cost that was planned to be financed by the Japanese ODA loan and ICE's own funds at the time of appraisal, had to be financed also by borrowing from the Central American Bank for Economic Integration (CABEI) and issuance of bonds, after changes in output and delays in the project period were made. These in turn resulted in a significant increase in interests during construction which was 1,153% compared to planned.

3.4.2.2 Project Period

The planned project period was 76 months from April 2001 to July 2007, but the actual project period was 131 months from April 2001 to February 2012. The actual project period was 172% of the planned period, which was significantly longer than planned.

Table 7: Project Period

| Procedure | Planned (Appraisal documents) | Actual | Actual vs. Planned | Delay in starting |
|---|---|---|---|---|
| Signing of the L/A | April 2001 | April 2001 | — | |
| Preparatory Works | January 2001 to May 2005<br>53 months | January 2001 to September 2010<br>117 months | 221% | None |
| Main Works | January 2001 to July 2007<br>79 months | June 2002 to October 2010<br>101 months | 128% | 10 months |
| 1. RCC Dam | August 2001 to March 2007<br>68 months | June 2002 to November 2011<br>114 months | 168% | 10 months |
| 2. Headrace Tunnel | January 2001 to April 2007<br>76 months | July 2002 to May 2011<br>107 months | 141% | 18 months |
| 3. Powerhouse | January 2003 to July 2007<br>55 months | August 2005 to October 2010<br>55 months | As planned | 19 months |
| Electric Machinery and Equipment | July 2003 to March 2007<br>45 months | July 2003 to February 2012<br>104 months | 231% | None |
| Land Acquisition | January 2001 to June 2004<br>42 months | January 2001 to December 2006<br>72 months | 171% | None |
| Consulting Services | June 2001 to June 2007<br>73 months | July 2002 to May 2009<br>83 months | 114% | 13 months |
| Total Project Period | April 2001 to July 2007<br>76 months | April 2001 to December 2012<br>131 months | 172% | — |

Source: Planned values are from JICA appraisal documents, actual values are from ICE.

The main reasons for the delay were as follows.

1) Delays due to changes in civil works: the aforementioned change in the design of the dam resulted mainly in the delay of preparatory works (221% compared to plan). It also became necessary

to secure labor and add and/or change access roads in order to deal with such changes. In addition, regarding all sorts of ground works including grouting32 of the planned construction site of the dam, it took longer than expected to procure the necessary machinery due to lack of domestic funds. Another reason for the delay was that the water inflow in the tunnel connecting the RCC dam and the powerhouse was more than planned, which resulted in frequent flooding. However, the executing agency introduced a shift-work system and took measures such as using part of the equipment used in other projects. As for the construction of the power house, land acquisition was not completed until 2005 also causing a delay.

2) Delays due to the contract of Consulting Services: General competitive bidding is basically the public procurement procedure applied in Costa Rica. However, the project's consulting services were directly appointed based on the "Guidelines for the Employment of Consultants under ODA Loans". ICE had to provide necessary explanations for that the said Guidelines are superior to Costa Rica's national procurement laws in implementing ODA loan projects and had to carry out necessary coordination with Costa Rica's government and related entities . This resulted in a 13 month delay in signing the contract with the consultant, which in turn resulted in a delay in the items that were included in the consultant's Terms of Reference (TOR), such as Detailed Design and procurement procedures of the civil works.

3) Delays due to the tropical storm Alma: Due to the 2008 tropical storm Alma, civil works at the dam site had to be interrupted, and as mentioned earlier, contract with Astaldi had to be modified. Negotiations and procedures took time, which resulted in delays in the construction period. In addition, even after ICE took over the construction from Astaldi, it had to secure the necessary labor force by itself, which required time. Furthermore, the closing of access roads due to landslides resulted in delays in the delivery and installation of equipment[33].

3.4.3 Results of Calculations of Internal Rates of Return (IRR)

At the time of appraisal only the Economic Internal Rate or Return (EIRR) was calculated at 12.2%. Costs used for EIRR calculation were project costs and operation and maintenance costs, while benefits used were the income from sales of electricity and benefits deriving from avoiding blackouts. Project life was 40 years. At the time of the ex-post evaluation, although it was possible to obtain information on costs, it was difficult to obtain accurate information on the project benefits; therefore EIRR was not recalculated.

[32] Filling voids with cement milk and/or mortar in other to improve the foundation ground of a dam site (Source: website of the Japan Dam Foundation).

[33] One reason for the difficulty to secure labor force was that during the same period, a private company was carrying out a tourist developing project in Puntarenas and Guanacaste on the Pacific Ocean side, and they were offering higher wages, and therefore labor force was drawn into that project. In an effort to minimize any effects on the project, ICE carried out several "Job fairs" for Pirris neighboring residents. It also added a camp in the dam site where accommodation facilities, meals and buses for transportation were offered.

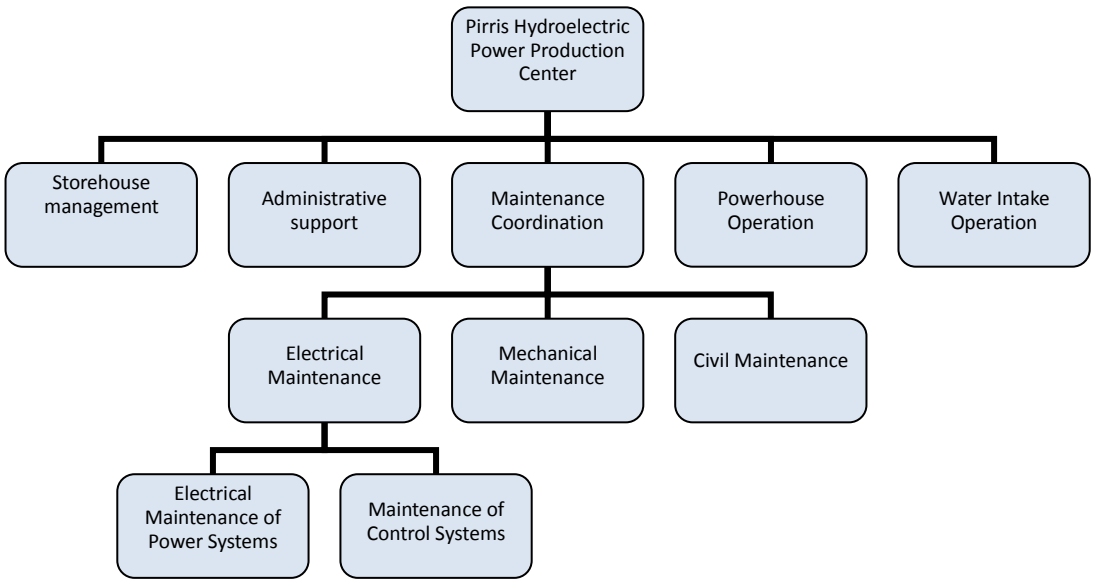
Both project cost and project period significantly exceeded the plan, therefore efficiency of the project is low.

### 3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

The project's operation and maintenance during project execution was conducted as planned by the PHP established under the Strategic Business Unit for Projects and Related Services (UEN-PySA) of ICE Electricity (ICELEC). The Project Manager was the head of PHP, under whom there were a total of 14 departments including Project Management, Operation Planning, Quality Control, Materials and Equipment Procurement, Labor Safety Management, Environmental Management, IT Management, Civil Works, and Engineering among others. From June 2009 to October 2010, which was the project's peak period, there were 2,884 persons engaged. In addition, during emergency periods such as when tropical storm Alma hit the country, labor force was reinforced. From these, it can be said that there were no major problems in general terms in ICE's basic organization during project execution.

The operation and maintenance of the PHPP at the moment of the ex-post evaluation is conducted by the Pirris Hydroelectric Power Production Center (Figure 6). There are a total of 45 employees, including engineers, technicians and skilled workers, engaged in the operation and maintenance, and the average years of service are nine years, which is relatively long. In addition, when there is a vacancy, employees within ICELEC are invited to fill up such vacancy. The status of the operation and maintenance and work site at the moment of the ex-post evaluation, as well as interviews to employees including technicians, showed that there is a high level of ownership by these employees toward the plant and that the operation and maintenance of PHPP is in good order.




Source: ICE.

Figure 6: Organization chart of Pirris Hydroelectric Power Generation Center

3.5.2 Technical Aspects of Operation and Maintenance

With respect to the technical level of the personnel in charge of PHPP is as follows: four out of the 45 are university graduates, 29 are technicians, six are administrative personnel, six are skilled workers, and judging from the maintenance status, in general terms, technical level is sufficient. However, ICE is aware that although the current technical level is enough, for the future, it is necessary to improve employee's skills through trainings related to power generation techniques and maintenance. ICE has a "Training Program to Fill Skill Gaps" which is provided to all its employees. These trainings have the objective of both filling the skill gap that exist between any employee and the skills that his/her job requires, as well as further improving skills. Through this program, the skills of the personnel in charge of the operation and maintenance of PHPP are also being improved. The following table indicates some of the trainings that the maintenance personnel of PHPP took during 2013 and those that were planned for 2014.

Table 8: Examples of trainings of PHPP's maintenance personnel

| Examples of trainings conducted in 2013 | | Examples of trainings planned for 2014 | | |
|---|---|---|---|---|
| Title of training course | No. of persons | Title of training course | No. of persons | No. of hours |
| Mathematics for Technicians | 16 | Metrology | 3 | 16 hrs. |
| How to read a Plan | 15 | Basic Knowledge on Centrifugal Pumps | 3 | 16 hrs. |
| Basic Electrical Engineering | 23 | How to read a Plan | 6 | 16 hrs. |
| IT (software including API-PRO) | 30 | Civil Work Project Budget and Management | 6 | 40 hrs. |
| Thermography Measurement I | 5 | Automation Theory | 18 | 48 hrs. |
| Reliability-Centered Maintenance(RCM) | 2 | Human Relations in the Workplace | 45 | 8 hrs. |
| Vibration Measurement and Alignment | 2 | Procedures for Sustainable Improvement | 45 | 8 hrs. |

Source: ICE.

Some of the engineers and technicians that are in charge of the maintenance used to belong to the PHP during project execution, and because of that experience, they have full knowledge of the PHPP, which in turn results in a high technical level of the operation and maintenance of the plant.

Maintenance of PHPP is conducted based on detailed maintenance manuals and plans of the respective equipment provided by the manufacturers. The original maintenance manuals are kept in the library of the PHPP, and the detailed information (maintenance procedures of each equipment, frequency, records, etc.) has been digitalized and are managed using the maintenance system "API-PRO". Maintenance procedures of all equipment strictly follow the standards of ISO9001, 14001 and 18001. Maintenance is conducted by equipment, and there are daily inspections as well as

Figure 7: View of the Storehouse

preventive maintenance[34] (every week, month, semester, year, and every other year). With respect to corrective maintenance, the warranty period of almost all the equipment was until December 2013, thus repairs were conducted free of charge by the manufacturers up to that date. After the expiration of the warranty period, those repairs that can be done by ICE's maintenance coordination department are done in-house, and those repairs that cannot be conducted internally, are done by the manufacturers with charge. All the information on maintenance procedures and measures taken are inputted by the person in turn into the API-PRO. Thus, information including the person in charge of maintenance, date when the maintenance was conducted and number of spare parts used, is always updated. In addition, this system is also used for the management of spare parts, and the Storehouse Management Department manages the spare parts based on this system. At the moment of the ex-post evaluation, it was possible to see the whole maintenance procedure using the API-PRO, and also to confirm the coordination that exists with the storehouse department, from which it can be said that the technical level of maintenance that exists at the PHPP is high.

3.5.3 Financial Aspects of Operation and Maintenance

ICELEC has been in the black for the past five years with the exception of 2011 in which the effects of the global financial crisis were still present, and so financial sustainability has no major problems. Although capital-to-asset ratio in 2012 was 51%, which was lower than the 59% recorded in 2009, it is still high; operating profits is constantly increasing indicating that operation and maintenance costs is being covered with the income from the electricity bills[35].

Table 9: ICELEC Profit and Loss Statement

(Unit: Million Colon)

| | 2009 | 2010 | 2011 | 2012 | 2013 (up to November) |
|---|---|---|---|---|---|
| Operating Income (A) | 521,995 | 539,889 | 553,255 | 575,862 | 652,004 |
| Electricity business | 516,697 | 532,234 | 546,273 | 569,118 | 645,451 |
| Others | 5,297 | 7,655 | 6,982 | 6,744 | 6,554 |
| Operating Cost (B) | 441,503 | 479,420 | 517,541 | 525,327 | 486,161 |
| Maintenance cost | 381,245 | 417,294 | 438,457 | 443,397 | 479,782 |
| Operation cost | 60,258 | 62,126 | 79,084 | 81,930 | 63,739 |
| Operating profit (A) –(B) | 80,492 | 60,470 | 35,714 | 50,535 | 165,843 |
| Non-operating income | 24,101 | 183,506 | 119,406 | 112,108 | 87,138 |
| Non-operating cost | 66,246 | 140,133 | 161,030 | 156,545 | 112,651 |
| Income from dividends of subsidiary companies | 5,486 | 8,275 | (699) | 4,993 | - |
| Current Net Profit | 43,832 | 112,117 | (6,609) | 11,090 | 82,970 |

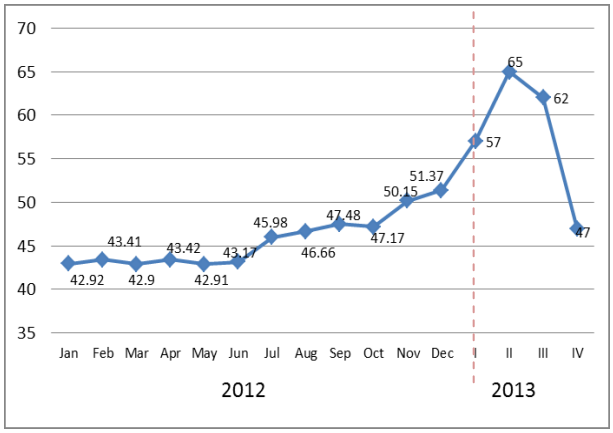
Source: Financial Statements provided by ICELEC.

Electricity tariffs in Costa Rica are fixed based on the Regulatory Authority for Public Services

[34] Preventive maintenance is the maintenance conducted in a planned manner before facilities and equipment breakdown or deteriorate. On the other hand, corrective maintenance is to repair facilities and equipment that are already damaged.

[35] Moody's, one of the major bond rating organizations, gave ICE a credit rating of Baa3 in September 2013, and changed the future prospect to "Negative". However, it gave a positive evaluation of "Stable" to ICELEC's electricity business.

(ARESEP) Law No. 7593. This Law is based on the principle that "electricity tariffs shall be enough to cover the necessary cost for the provision of electric services, create competitive benefits and secure proper development". Since January 2013, it was approved that fluctuation of fuel costs be reflected on electricity tariffs on a quarterly basis. As can be seen, the electricity tariff system is established in such a way that it secures the tariff income to cover the operation and maintenance costs. However, it is also true that the industrial sector, who is arguing that increases in electricity tariffs are putting pressure in the companies' management, decreasing their competitiveness, is increasing movements and lobbying activities to revise electricity tariffs.




Source: ICE

Figure 8: Fluctuation of Electricity tariffs (Colon/kWh)

With respect to the operation and maintenance of PHPP, budget for the ordinary maintenance costs (daily inspection, preventive maintenance and corrective maintenance) is secured and is implemented as planned[36].

Table 10: Operation and Maintenance Budget of the PHPP

(Unit: million colons)

| | 2011 | 2012 | 2013 |
|---|---|---|---|
| Operation | 101.5 | 259.2 | 552.4 |
| Maintenance | 81.0 | 338.4 | 462.8 |
| Total | 182.5 | 597.6 | 1,015.2 |

Source: Pirris Power Generation Center

3.5.4 Current Status of Operation and Maintenance

Operation of the PHPP at the time of the ex-post evaluation was being conducted properly, and facilities and equipment installed by the project were mostly operating normally. At the time of the ex-post evaluation the problems indicated below were identified. With the exception of the concrete

[36] According to the data of the 2013 operation and maintenance budget requested by the Pirris Power Generation Center to ICE, which was made available by the said Center, it became clear that approximately 900 million colons were requested, out of which only 462.8 million colons were approved. After confirming the details, it was confirmed that the difference was mainly the budget for a backup transformer, and that the necessary budget to conduct a proper maintenance of the power plant has been secured. The budget for the backup transformer is planned to be included in the 2015 budget request.

lining in some parts of the headrace tunnel, these problems were not because of deficiencies in the design nor in the construction stage. Measures have already been taken and it was confirmed that these are included in specific repair plans.

Table 11: Maintenance status at the time of project completion and ex-post evaluation

| | Problems | Status as per April 2014 |
|---|---|---|
| RCC Dam | • Problems with the electrical system<br>• Water leakages in the radial gate<br>• Elevator out of order | • Repaired<br>• Repaired<br>• Repaired |
| Powerhouse | • Elevator out of order<br>• Damages in the hydraulic governor of the Second Turbine | • Repaired<br>• Repaired |
| Headrace tunnel | • Problems with the valve<br>• Tunnel concrete lining is partially incomplete<br>• Wear of instruments exposed in the valve area<br>• Paint stripping at the high-pressure pipe | • Not repaired. It is necessary to clear the water from the headrace tunnel to do the repair. Thus during 2014, scale, scope and timing of the repair will be assessed, and it will be included in the repair plan after 2015<br>• Concrete lining is planned to be conducted by including it in the 2015 or 2016 maintenance plan<br>• A shed to protect the exposed instruments is planned to be constructed by the end of August 2014<br>• Being painted by a contractor |
| Intake | • Unsuitable operation of the water intake measurement system | • Repaired and being monitored |

Source: Based on interviews to ICE Pirris Power Generation Center and responses to the questionnaire.

With respect to spare parts, there is a storage house for materials and equipment inside the premises of the power house, and because it is linked to the maintenance system as mentioned earlier, inventory management is sufficient. In addition, during the ex-post evaluation survey it was possible to confirm that ISO standards related to security management, cleanliness and tidiness are being followed strictly both at the power house and at the RCC dam. From the above, it is clear that operation and maintenance are conducted properly, and from a general point of view, it can be said that the current status of the operation and maintenance is good.

The project's operation and maintenance institutional structure was sufficient both during project execution as well as after project completion and technical level of maintenance is high. Financial status is also in the black with the exception of 2011, and from 2009 operating profits have always been positive, which confirms that electricity tariffs are sufficient to cover operation and maintenance costs. With respect to maintenance status, although there are some issues in some equipment, these have already been included in the 2015 and 2016 maintenance programs in which specific repair and replacements have been planned. From the above, the project's institutional organization, technical level and financial status have no major problems, therefore sustainability of the effect brought about by project is judged to be high.

## 4. Conclusion, Recommendations and Lessons Learned

### 4.1 Conclusion

The project aimed to improve the stability of electric supply capacity in Costa Rica by constructing a hydroelectric power plant in the middle stretches of the Pirris River which runs through the central plateau of the country.

The project was in line with Costa Rica's national development plans, development needs and Japan's assistance policies, both at the time of the appraisal and at the time of the ex-post evaluation. Therefore its relevance is high. The main indicators which reflect the effects of the PHPP have either mostly achieved its targets or are improving. In addition, in a country where hydroelectric power generation is the base load, the project has not only strengthened the hydroelectric generation capacity, but it has also contributed to a more stable electric supply capacity as well as to solving future electricity supply-demand gaps. These effects can be recognized as the PHPP is connected to the National Electricity System, through the Parrita-Lindora transmission line (230kV, 118km) which was constructed as a separate project of the Executing Agency. Based on the above, the project effectiveness is evaluated to be satisfactory. In addition, other positive impacts were observed such as afforestation activities and effects from the construction of access roads, among others, thus the project's level of achievement of its intended effects and impacts is high. The efficiency of the project is evaluated to be low, because both project period and project cost significantly exceeded the plan. With regard to the sustainability of the effects of the project, no major problems have been observed in the institutional, technical and financial aspect of operation and maintenance, therefore sustainability of the project effect is high.

In light of the above, this project is evaluated to be satisfactory.

### 4.2 Recommendations

#### 4.2.1 Recommendations to the Executing Agency

It is desirable that the problems indicated in the Status of Operation and Maintenance section are solved by carrying out the maintenance program exactly as planned. According to the executing agency, especially with respect to the valve of the conveyance works, it might become necessary to empty the tunnel, thus it is imperative to have a clear idea of when to do the repair work. Since this means that the operation of the PHPP would have to be stopped temporarily, the management team of ICELEC is urged to assess possible measures, include them in the repair program and conduct the repair as soon as possible.

#### 4.2.2 Recommendations to JICA

None.

### 4.3 Lessons Learned

**Improving the accuracy of the geological survey at the time of the Detailed Design**

In this project, at least three geological surveys were conducted if the 1992 F/S is included. Due to time constraints for the geological survey in the 1992 F/S, it was advised that a more detailed geological survey should be conducted. Afterwards, ICE carried out additional surveys as well as another F/S, until finally reaching the signing of the Loan Agreement. However, after starting of civil works, it was found that there were problems in the soil of some of the construction sites, resulting in design changes. These changes significantly affected the project output, costs and period. Just as ICE itself has indicated as one lesson learned, a more detailed geological survey must have been done. That is, at the time of the detailed design, it would have been possible to minimize changes in the design of the dam by carrying out more accurate geological surveys in terms of boring survey area, frequency, interval and depth. These measures would have led to a more efficient implementation of the project.

End

**Comparison of the Original and Actual Scope of the Project**

| Item | Original | Actual |
|---|---|---|
| I. Project Outputs | | |
| [Civil Works] | | |
| 1. Preparatory Works | | |
| a. Access roads for works | 70km | 145km |
| b. Camp sites | 3 | 4 |
| c. Queries | 6 | As planned |
| 2. RCC Dam | Effective storage capacity: 30 million $m^3$<br>Area:1.14$km^2$<br>Height of the dam: 113m | Effective storage capacity: 36 million $m^3$<br>Area: 1.4$km^2$<br>Height of the dam: As planned |
| 3. Water Intake | Crest length:270m<br>H:58m×L:9m×W:8m<br>Discharge:18$m^3$/s | Crest length: As planned<br>H:32m×L:7.1m×W:7.1m<br>Discharge: As planned |
| 4. Headrace tunnel from dam to powerhouse | 10.6km | 10.5km |
| 5. Penstock | 1,170m | 1,144m |
| 6. Powerhouse | Generation capacity: 128MW<br>Electric power generation: 561GWh<br>L:50m×H:20m×W:30m | Generation capacity: 138MW<br>Electric power generation: 503.65GWh<br>L:43.8m×H:18.6m×W:22.3 m |
| 7. Tailrace | 262m / Diameter: 3.3m | As planned |
| [Electromechanical Equipment and Facilities] | | |
| 8. Generator | 76MVA, 60Hz, 720RPM, W41×2 | As planned |
| 9. Turbine | 64MW, 830.7m, 720RPM×2<br>(Pelton turbine) | 69MW, 830.7m,720RPM×2<br>As planned |
| 10. Main Transformer | 13.8/230kV×3 | As planned |
| 11. Switchyard | 230kV×1 | As planned |
| 12. Communication facilities for electrical control | ISDN<br>Optic fiber link<br>Radio system | As planned<br>As planned<br>As planned |
| [Consulting Services] | Assistance of Detailed Design; review of Tender Documents, assistance of tendering process; assistance of construction supervision; assistance for project management | As planned |
| II. Project Period | April 2001 - July 2007<br>(76 months) | April 2001 - December 2012<br>(131 months) |

| | | |
|---|---|---|
| III. Project Cost | | |
| Amount paid in Foreign currency | 15,144 million yen | 36,326 million yen |
| Amount paid in Domestic currency | 14,299 million yen<br>(132 million US dollars) | 42,729million yen<br>(415 million US dollars) |
| Total | 29,443million yen | 79,056million yen |
| Japanese ODA loan portion | 16,683 million yen | 16,402 million yen |
| Exchange rate | 1 U.S. dollar = 108.36 yen<br>(As of November 2000) | 1 U.S. dollar = 103.03 yen<br>(Average of monthly rates between April 2001 and 2011)<br>Source: ICE |

United Mexican States

Ex-Post Evaluation of Japanese ODA Loan

Baja California Water Supply and Sanitation Project

External Evaluator: Hiromi Suzuki S., IC Net Limited

## 0. Summary

This project aimed to solve water pollution problems by developing the water supply and sewerage infrastructure of three cities in Baja California, namely Mexicali, Tijuana and Ensenada.

This project was in line with the development plans of the Mexican government and the Baja California state government and their development needs as well as with Japan's ODA policy at the times of the appraisal and the Ex-Post Evaluation. Therefore its relevance is high. All the operation and effect indicators for water supply and sewerage systems have improved greatly in each city. The targets set at the time of the appraisal were achieved or the values are improving steadily. Although the water supply and sewerage project in Tijuana includes the unfinished Tecolote-La Gloria Sewage Treatment Plant, the State Commission for Public Services of Tijuana (Comisión Estatal de Servicios Públicos de Tijuana, hereinafter referred to as CESPT) constructed temporary small-scale sewage treatment plants using its own funds and it is providing a partial service. Therefore, the sewerage development project in Tijuana has been effective despite the delay in the development of the Tecolote-La Gloria Sewage Treatment Plant. The External Evaluator found evidence of project effects including a reduction in river water pollution, an improvement in the residents' living conditions, an improvement in environmental problems concerning Mexico and the US and the reuse of treated sewage by the State Commission for Public Services of Mexicali (Comisión Estatal de Servicios Públicos de Mexicali, hereinafter referred to as CESPM) and CESPT (Tijuana). Therefore the project's effectiveness and impact is high[1]. Although the project cost was within the plan, the project period has significantly exceeded the plan because the Tecolote-La Gloria Sewage Treatment Plant is unfinished. Therefore the efficiency of the project is fair. Some problems have been observed in terms of the financial aspects of the operation and maintenance system administered by the State Commissions for Public Services in all three cities. Some problems have also been observed in terms of the technical aspects of the operation and maintenance system administered by the State Commission for Public Services of Ensenada (hereinafter referred to as CESPE). Therefore sustainability of the project effect is fair.

In light of the above, this project is evaluated to be satisfactory.

[1] The policy of this Ex-Post Evaluation was that the External Evaluator would check the overall effectiveness while also checking the effectiveness of the project in each city.

## 1. Project Description


Project Locations

Monte de Los Olivos Sewage Treatment Plant (Tijuana)

### 1.1 Background[2]

Baja California is situated in Northwestern Mexico and has a border with the US. At the time of the appraisal, the three cities subject to the project (Mexicali, Tijuana and Ensenada) were receiving a large amount of foreign direct investment and were experiencing remarkable economic development as they were part of the Border Industrialization Program. Many people from other parts of Mexico migrated to the cities looking for jobs and the unemployment rate in the area was 2.2% which is lower than the national average of 3.3%[3]. The Mexican government attached importance to Baja California due to the large numbers of people traveling between the state and the US and the important economic role that the state plays.

In Baja California, infrastructural development for daily life lagged behind the rapidly growing population. For the National Water Commission (Comisión Nacional de Agua, hereinafter referred to as CONAGUA), the development of water supply and sewerage systems had a particularly high priority in its national water infrastructure development program. The water pollution problem in the state had become so serious that it was discussed at a bilateral summit with the US, and there was an urgent need to solve the problem. The improvement of living conditions in Baja California was of major importance to Japan because about 40% of the foreign direct investment in the state in the latter half of the 1990s came from Japan (581 million US dollars). Japanese-owned businesses had the largest number of employees among foreign companies operating in the state, accounting for about 40% (14,000 employees) of the total number of foreign company employees. It is with this background that the Mexican government requested the ODA Loan to the Japanese government.

[2] Created based on press releases and JICA's materials given at the time of the appraisal.
[3] JICA's materials given at the time of the appraisal, the National Institute of Statistics and Geography of Mexico (Instituto Nacional de Estadística, Geografía e Informática, hereinafter referred to as INEGI)

### 1.2 Project Outline

The objective of this project is to resolve river water pollution by developing the water supply and sewerage infrastructure of three cities in Baja California namely Mexicali, Tijuana and Ensenada, thereby contributing to improving the living conditions of residents in the three cities and curbing environmental problems in Mexico and the US.


Source: INEGI

Figure 1: Project Locations

| | |
|---|---|
| Loan Approved Amount/ Disbursed Amount | 22,148 million yen / 22,053 million yen |
| Exchange of Notes Date/ Loan Agreement Signing Date | March 2000 / March 2000 |
| Terms and Conditions | Interest Rate: 2.5% (1.8% for the development of sewerage systems as part of the project and consulting services)<br>Repayment Period: 25 years (Grace Period: 7 years)<br>Condition for Procurement: General untied |
| Borrower / Executing Agencies | The National Bank of Public Works and Services (Banco Nacional de Obras y Servicios Públicos S.N.C., BANOBRAS) / Comisión Estatal de Servicios Públicos de Mexicali (CESPM), Comisión Estatal de Servicios Públicos de Tijuana (CESPT), Comisión Estatal de Servicios Públicos de Ensenada (CESPE) |
| Final Disbursement Date | July 2009 |
| Main Contractors (Over 1 billion yen) | Arca del Pacifico, S. de R.L. de C.V. y Asociados (Mexico), Constructora Cadena, S.A. de C.V. Y Asociados (Mexico), Alepo Construcciones, S.A. de C.V., Asociación en Participación (Mexico), Grupo Construcciones Planificadas, S.A. (Mexico), Degremont, S.A. de C.V. y Asociados |

| | |
|---|---|
| | (Mexico), Earth Tech México, S.A. de C.V. (Mexico), Constructora Makro, S.A. de C.V., A en P. (Mexico), Fypasa, Cotrisa y Construplan, S.A. de C.V. (Mexico) |
| Main Consultants (Over 100 million yen) | Nippon Jogesuido Sekkei Co., Ltd. (Japan) / Black & Veatch International (the United States) (JV) |
| Feasibility Studies, etc. | F/S: Conducted by the Baja California state government (1997)<br>Special Assistance for Project Formation for the Baja California Water Supply and Sanitation Project (1998) |
| Related Projects | [Japanese ODA Loan projects]<br>Monterrey Water Supply and Sewerage Project (L/A signed in 1992)<br>Metropolitan Mexico Sanitation Project (L/A signed in 1997)<br>[Technical cooperation projects]<br>Project on Capacity Enhancement for Establishing Mexican Norms of Water Quality Criteria (implemented in 2008–2010)<br>[Other international organizations and aid organizations]<br>North American Development Bank (NADB): The Sewage Treatment System Improvement Project (1997) |

## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Hiromi Suzuki S. (IC Net Limited)

### 2.2 Duration of Evaluation Study

Duration of the Study: September 2013 - January 2015

Duration of the Field Study: November 30 - December 16, 2013 and April 24 - May 11, 2014

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

### 3.1 Relevance (Rating: ③[5])

3.1.1 Relevance to the Development Plan of Mexico

3.1.1.1 The Development Plans at the Time of the Project Appraisal

At the time of the project appraisal, the National Water Use Program (2001–2006) was

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

[5] ③: High; ②: Fair; ①: Low

formulated for the water supply sector based on the National Development Plan (1995–2000)[6]. The program aimed to promote the deregulation and streamlining of water use and the removal of pollutants from watershed areas which discharge wastewater, in order to enable the sustainable development of water resources and water use[7] [8].

The Baja California state government formulated the Baja California State Development Plan (1996–2001) based on the National Development Plan. In the plan, it set 11 goals in total with the aim of improving residents' living conditions, including social infrastructural development and the improvement of health and hygiene. In particular, water supply and sewerage development were priority areas for the improvement of living conditions. The Baja California Water Supply and Sanitation Project was the core part of the water supply and sewerage development stipulated in the plan.

3.1.1.2 The Development Plans at the Time of the Ex-Post Evaluation[9]

The National Development Plan (2013–2018) at the time of the Ex-Post Evaluation prioritized "the achievement of an equal society" and "productivity improvement," among others. For the water supply sector, it set a policy of improving water supply services and access to basic infrastructure, while promoting sustainable water resource development. The National Water Use Program (2014–2019) aimed at "ensuring the safety and sustainability of water resources" and included "improving water supply and sewerage services and strengthening access to the services" in six priority areas.

The Baja California State Development Plan (2008–2013) states that it would continue to prioritize water supply and sewerage development, water recycling and water resource management. In particular, the plan emphasizes that water resources are common resources of the US and Mexico and that bilateral agreements should be taken into account when using, discharging and managing water resources. The Baja California State Water Use Program (2008–2013) sets detailed plans for achieving the goals of the State Development Plan. The program gives four strategies: (1) expansion of the water supply and sewerage service area and the qualitative improvement of the services as well as the promotion of water recycling; (2) the development of new water resources; (3) participatory water resource management where government, citizens, businesses, etc. participate and the strengthening of cooperation with the

[6] The plan aimed at two goals: the promotion of economic activities by tapping into urban and local characteristics; and the urban development of highly populated areas while maintaining harmony with the environment.
[7] Water used for urban life, industrial and agricultural purposes.
[8] To achieve these goals, ten specific measures were set. In particular, the priority measures included the promotion of investment in infrastructural development and maintenance, and the efficient operation of the water use projects.
[9] As of April 2014, the Baja California State Water Use Program (2014–2019) had not been published. Therefore, in the Ex-Post Evaluation, the relevance between this project and the state-level development plans was checked based on the Baja California State Development Plan (2008–2013) and the Baja California State Water Use Program (2008–2013).

US; and (4) the strengthening of technology, management, finance, etc. for water supply and sewerage businesses. All these are highly relevant to this project.

As explained above, the national and state development plans prioritized the improvement of the water environment and living conditions through the development of water supply and sewerage infrastructure both at the time of the project appraisal and the Ex-Post Evaluation. The Baja California State Water Use Program at the time of the Ex-Post Evaluation set a development goal of strengthening cooperation with the US in the water environment field. The above-mentioned items are relevant to this project.

### 3.1.2 Relevance to the Development Needs of Mexico

#### 3.1.2.1 The Development Needs at the Time of the Project Appraisal

The three cities subject to this project were experiencing rapid economic growth even when compared to other cities in Mexico (see "1.1 Background") and there was a marked concentration of the population in the area due to people migrating from other states looking for jobs[10]. However, the development of water supply and sewerage systems lagged behind the rapid population increase. At the time of the appraisal, the water supply coverage was 97% in Mexicali, 88% in Tijuana and 89% in Ensenada, and the sewerage system coverage was only 89%, 61% and 71%, respectively. In addition to constructing new facilities, investment in rehabilitation and the extension of existing facilities was considered urgent.

Baja California has an approximately 226km border with the US and shares the Colorado River, the New River and the Tijuana River with the US. At the time of the appraisal, some of the sewage in the state was discharged into the New River without being treated. The polluted water then flew into the Salton Sea in the US and was degrading the environment. This water pollution problem developed into a diplomatic problem between Mexico and the US. Therefore, this project was considered urgent by the Baja California state government, which aimed to improve the living conditions of the residents of the state and to solve the bilateral problem quickly.

#### 3.1.2.2 The Development Needs at the Time of the Ex-Post Evaluation

The annual population growth rate in Baja California has been decreasing in general since it reached 4.3% in 2000. According to the 2010 census, the average annual population growth rate from 2000 to 2005 was 2.7% and the average annual population growth rate from 2006 to 2010 was 2.2%[11]. These figures were lower than the 3.5% which had been projected at the time of the project appraisal. The water supply coverage has significantly increased in all three cities (100%

[10] The population was growing rapidly with an average annual growth rate of 3.5% (the national average in 1980–1990 was 1.9%). This increasing trend was expected to continue.
[11] The national average population growth rate in 2005–2010 was 1.8%.

in Mexicali, 99% in Tijuana and 99% in Ensenada), but the sewerage system coverage remains 95%, 89% and 93%, respectively, and continuous development is needed. Tijuana has less sewerage system coverage than the other cities because the population is rapidly increasing in the area covered by CEPST's sewage treatment service. Therefore, there is still a strong need for sewerage development[12].

On the other hand, the water quality in the Colorado River, the New River and the Tijuana River which developed into a bilateral problem with the US has been greatly improved due to many projects being implemented based on treaties and arrangements that were put in place by the International Boundary and Water Commission (hereinafter referred to as the IBWC). The IBWC is a bilateral commission established by the two countries. At the time of the Ex-Post Evaluation, the quality of the treated water discharged into the rivers met the national standards[13] (NOM-001-SEMARNAT-1996).

As explained above, at the time of the Ex-Post Evaluation, there were still a strong development needs for the expansion of the water supply and sewerage system coverage and the improvement of the water environment in the three cities subject to the project. Curbing the environmental problem in Mexico and the US was one of the expected impacts of the project. The situation has improved greatly due to various bilateral efforts, but further improvements in water quality are hoped for.

### 3.1.3 Relevance to Japan's ODA Policy[14]

In Japan's Medium-Term Policy on Official Development Assistance (August 1999) which was in use at the time of the project appraisal, Japan's basic ODA policy was to assist with economic and social infrastructure, to assist with intangible projects such as human resource

[12] There are multiple reasons for the low sewerage system coverage in Tijuana. For example, the migrant population from other states is increasing. Also, the border between Tijuana and San Diego in the US has the largest number of people traveling through it in the world, and Tijuana has an increasing floating population from Mexico and elsewhere who aim to enter the US. In addition, Playas de Rosarito (a city covered by CESPT's sewage treatment service) has a high average annual population growth rate (4.5% in 2005–2010). Playas de Rosarito receives the population which spills over from Tijuana.

[13] The national standards for domestic water supply (Mexico's official set of rules) are stipulated in NOM-127-SSA1-1994 issued by the Secretariat of Health. The laws on the water quality standards for sewage discharge are stipulated in NOM-001-SEMARNAT-1996 (the water quality standards for discharging sewage into coastal areas), NOM-002-SEMARNAT-1996 (the water quality standards for discharging sewage into urban sewerage networks) and NOM-003-SEMARNAT-1997 (the water quality standards for reusing the water resulting from sewage treatment for public services) which were issued by the Secretariat of the Environment and Natural Resources. All the standards stipulate the maximum permissible levels for 17 pollutants in total, including suspended solids (SS), biochemical oxygen demand (BOD), total nitrogen (TN) and total phosphorus (TP) (see footnotes 21 and 27 for details of SS and BOD). Sewage treatment plants must at least observe NOM-001-SEMARNAT-1996 strictly. When treated water is to be reused for public services, the stricter NOM-003-SEMARNAT-1997 must be met.

[14] At the time of the project appraisal, Japan did not have ODA policies specifically for Mexico (such as a "Country Assistance Program for Mexico" or a "Country Assistance Strategy for Mexico." Therefore, in this Ex-Post Evaluation, the relevance between this project and Japan's ODA policy was checked by looking at the following documents: the Medium-Term Policy on Official Development Assistance (August 1999) which is Japan's basic ODA policy; JICA's Medium-Term Strategy for Overseas Economic Cooperation Operations (December 1999) which was established based on the Medium-Term Policy; and the Japan-Mexico Economic Cooperation Policy Dialogue (November 2001). JICA is the abbreviation of the Japan International Cooperation Agency.

development, the development of systems and policies, as well as to tackle global problems. In particular, assistance for Latin America focused on the conservation of the natural environment, responding to the increasing environmental impacts accompanied by economic growth, and the development of basic infrastructure for reducing regional economic disparities. In the Medium-Term Strategy for Overseas Economic Cooperation Operations, "support for economic and social development" was included in priority cooperation areas. In the Japan-Mexico Economic Cooperation Policy Dialogue, it was agreed that the two countries would cooperate on the priority areas of "reducing the disparities between regions and between the rich and the poor," "industrial development and the promotion of local development" and "environmental measures and the conservation of the natural environment."

Therefore, this project was relevant to Japan's ODA policy at the time of the appraisal because the project aimed at water supply and sewerage development and conservation of the water environment.

In light of the above, this project has been highly relevant to the country's development plan, development needs, as well as Japan's ODA policy. Therefore its relevance is high.

### 3.2 Effectiveness[15] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)[16]

Clear operation indicators, effect indicators or target values had not been set for water supply or sewerage projects before the Ex-Post Evaluation. Therefore, at the Ex-Post Evaluation, indicators were set as shown below based on the materials for internal use given at the time of the appraisal. The Ex-Post Evaluation was then conducted using the indicators.

3.2.1.1 Operation Indicators

a. Water supply projects: According to the materials for internal use, the population supplied with water (the additional population supplied with water[17]) and the percentage of non-revenue water were to be used as operation indicators. Therefore, the evaluation was conducted using

[15] Sub-rating for Effectiveness is to be put with consideration of Impact.

[16] This project was implemented by three executing agencies and was comprised of many sub-projects. Therefore the basic evaluation policy was to conduct an overall evaluation while also checking the project's effects in each city using the operation and effect indicators. The year of completion was different for the different cities. Therefore, the year in which water supply projects were completed in all three cities was considered the "year of completion" for the water supply projects, and the year in which sewerage projects were completed in all three cities was consider the "year of completion" for the sewerage projects. Therefore, the year of completion for the water supply projects was 2008 and the year of completion for the sewerage projects was 2010, and the evaluation was conducted for 2010 and 2012, respectively, which were two years after the year of completion.

[17] The materials state that the additional population supplied with water should be "200,000 people in Mexicali and 160,000 people in Tijuana," but they were not clearly defined as indicators. Therefore, in the Ex-Post Evaluation, the benchmark year was set to be 1999 and the target value at the time of the project completion was set to be the sum of the population supplied with water in 1999 and the additional population supplied with water mentioned above, for each city.

these items as operation indicators. The amount of water supplied, the facility utilization rate (average)[18] and the water quality (turbidity) were added as reference indicators (see Annex I, Table A). At the Ex-Post Evaluation, it was confirmed that the amount of water supplied increased from the amount at the time of the project appraisal. It was also confirmed that the facility utilization rate (average) exceeded the rate in 2007 (before the start of the project), and that the rate continued to increase in general after the development of facilities started their operations. The water quality was checked against the national standards.

Regarding the population supplied with water, the target achievement rate in 2010 (two years after the project's completion) was 96% in Mexicali and 133% in Tijuana. Therefore the project's effectiveness was confirmed. Regarding the percentage of non-revenue water, the targets were achieved both in Mexicali and in Tijuana. The evaluation results for the reference indicators are as follows. (1) The facility utilization rate: The rate increased from 23% in 2008 to 44% in 2013 at the newly built Xochimilco Water Treatment Plant. The rate increased from 65% in 2008 to 72% in 2013 at the improved Second Water Treatment Plant. The amount of water supplied and the facility utilization rate at both water treatment plants were increasing in general after the projects were completed. The figures declined temporarily after an earthquake measuring 7.2 on the Richter scale hit Baja California on April 4, 2010 which caused damage to water supply infrastructure and the stoppage of operations, but the figures started to increase in general afterwards. The facility utilization rates for the above two water treatment plants were expected to be 60-70% after the project was completed based on the forecast that the average annual population growth rate in 2000-2010 would be more than 3%[19]. However, in reality, the average annual population growth rate during this period was only 2%. Considering this fact, it was reasonable that the facility utilization rate at the Xochimilco Water Treatment Plant was below 50% and the facility utilization rate at the Second Water Treatment Plant was below 70%. Three water treatment plants in Mexicali including the ones developed by the project are connected to each other and a system is in place to enable the saving of electricity charges and other operational costs in accordance with fluctuations at different times of the day and in different seasons. This is enabling them to operate efficiently. (2) The amount of water supplied: Since 2007 the amount of water supplied in Mexicali has been lower than the amount in the benchmark year (1999). This is because citizens and businesses became more aware of the importance of water saving and factories in the maquiladora in Mexicali mainly started to use production processes in which they do not use water and this reduced total water consumption. This was not expected at the time of the appraisal. In addition, in light of the fact that the population growth rate forecast was higher than reality as mentioned above and that the amount of water supplied is only a reference indicator, the External Evaluator determined that the lower

[18] The facility utilization rate (average) = (the average daily water supply) ÷ (the capacity of the facility) × 100.
[19] A forecast made by INEGI at the design stage.

water supply level when compared to the benchmark year's level in Mexicali should not negatively affect the evaluation results of the project. (3) Water quality: The water quality in the two cities met the water quality standards (NOM-127-SSA1-1994) issued by the Secretariat of Health.

b. Sewerage projects: The amount of sewage treated and the population receiving sewage treatment service (whose data has been collected as reference information) have increased steadily (see Annex I, Table B). Regarding the facility utilization rate (see Annex II), nine out of a total of 10 sewage treatment plants which were developed by the project achieved a facility utilization rate of 40% which is considered the guideline value for efficient operation[20]. Only the El Sauzal Sewage Treatment Plant run by CESPE (Ensenada) did not achieve a facility utilization rate of 40%. This is because development in the El Sauzal area which was expected to take place at the time of the project appraisal was never implemented and the population did not increase. Therefore, the amount of sewage did not increase as expected. At the Monte de Los Olivos Sewage Treatment Plant in Tijuana which is run by CESPT (Tijuana), the facility utilization rate declined slightly from the end of 2011 due to lower generation of wastewater in the area covered by the said plant. In addition, at the moment of the Ex-Post Evaluation, the plant was having its annual preventive maintenance, and also fans were being repaired. However, the facility utilization rate is still above 40%.

Regarding the reduction rate for suspended solids (SS[21], see Annex II) which was another item to be used as an indicator at the time of the appraisal, the project targeted "a 70% reduction from the value at the time of the appraisal," but four sewage treatment plants in Mexicali did not achieve the target. In the discussion held with CESPM (Mexicali) on this target value, it was discovered that the four sewage treatment plants are situated in rural areas although they are categorized as urban areas by the National Population Council of Mexico (Consejo Nacional de Población, CONAPO), and the plants emitted only a small amount of SS in the first place. Therefore, CESPM considered that a 70% reduction was an excessive target. Since CONAGUA had the same view on the matter, it was decided that, in the Ex-Post Evaluation, the achievement of the SS reduction rate should be evaluated by looking at whether or not the SS values meet the national standards, as a more realistic alternative indicator. When checking the SS values against the national standards NOM-001-SEMARNAT-1996, all the sewage treatment plants met the standards.

As explained above, both the water supply and sewerage projects have achieved the target

[20] Based on JICA, "The Reference for Operation and Effect Indicators."
[21] SS (suspended solids) refer to insoluble particulate matter with the diameter of 2 mm or less which is suspended in water. They cause turbidity in water and prevent the sun's rays from penetrating the water. In a worst case scenario, they can block the gills of fish which causes death from suffocation (source: the website of the Ministry of the Environment of Japan).

values set for the operation indicators or the values are improving in general. The national standards for water quality have also been achieved. Therefore there are no major operational problems.

3.2.1.2 Effect Indicators

a. Water supply projects: According to the materials for internal use, water supply coverage was to be used as the effect indicator at the time of the appraisal. Therefore, the Ex-Post Evaluation was conducted using water supply coverage as the effect indicator (see Annex I, Table A). The majority of the water supply infrastructure was developed by 2008 and the water supply coverage increased greatly in all three cities by 2010 which is two years after the project's completion. The water supply coverage was 99.4% of the planned value in Mexicali and 102% of the planned value in Tijuana, i.e. it exceeded the planned value.

b. Sewerage projects: According to the materials for internal use, the sewerage system coverage was to be used as the effect indicator at the time of the appraisal. Therefore, the Ex-Post Evaluation was conducted using sewerage system coverage as the effect indicator (see Annex I, Table B). In Mexicali, the sewerage system coverage was 95.2% in 2012 which is two years after the project's completion (a six percentage point increase from the benchmark value). Sewerage system coverage also increased greatly in Tijuana and Ensenada and exceeded the target values. As a result, the sewerage project as a whole achieved the target value. The amount of reused water resulting from sewage treatment[22] increased greatly particularly in Mexicali after 2010. It is also increasing in general in Tijuana. The amount of reused water resulting from sewage treatment was around 0.2 million $m^3$/year in Ensenada, which is a lower level than the amounts in the other two cities. As explained at a later section, this is because CESPE (Ensenada) has not been able to engage itself in the promotion of sewage recycling due to technical and financial problems. The population receiving sewage treatment services and the amount of sewage being treated are steadily increasing in all three cities, and therefore the effectiveness of the project is high.

With regard to the quality of water discharged from sewage treatment plants which were constructed, improved or extended by the project[23], it was confirmed that the water quality from all the facilities met the national standards (NOM-001-SEMARNAT-1996) (see Annex III). The Tecolote-La Gloria Sewage Treatment Plant administered by CESPT (Tijuana) was unfinished at the time of the Ex-Post Evaluation. The sewage which was to be treated at the plant was

[22] This indicator is used by the executing agencies on a daily basis. During the Ex-Post Evaluation Study, this indicator was added after consulting with the executing agencies because it could be used as a quantitative effect indicator.

[23] Although the water quality had not been designated as an effect indicator at the time of the appraisal, it was added to the effect indicators after consulting with the executing agencies, because it is essential to check the quality of discharged water in order to understand the effect of the sewage treatment plants quantitatively.

treated at five sewage treatment plants constructed and run by CESPT (Tijuana) and a private real estate developer[24]. The quality of water discharged from all these plants meets the national standards[25]. According to CESPT (Tijuana), these sewage treatment plants cover about 30% of the population planned to benefit from the Tecolote-La Gloria Sewage Treatment Plant and covers about 50% of the amount of sewage to be treated at the plant. The remaining 50% of sewage is discharged into rivers without being treated. Therefore, the fact that the Tecolote-La Gloria Sewage Treatment Plant is unfinished is having negative effects on the living conditions of local residents and the natural environment. However, the treatment capacity of the Tecolote-La Gloria Sewage Treatment Plant accounts for only 4% of the total treatment capacity of the nine treatment plants developed by the project (3,004 L/s). When the plant is completed, further improvements to water quality and the living conditions of local residents can be expected (Please see Table 5 for details of the current status of Tecolote-La Gloria Sewage Treatment Plant).

Therefore, the water supply and sewerage projects have been effective in general in Mexicali and Tijuana. Although the Tecolote-La Gloria Sewage Treatment Plant in Tijuana is unfinished, the treatment capacity of the plant accounts for only a small percentage of the total capacity developed by the project. CESPT (Tijuana) is taking all possible alternative measures and they have been effective. The sewage projects in Ensenada have also been effective. Therefore, in light of the analysis results for each city, the External Evaluator determined that the project has been highly effective.

#### 3.2.2 Qualitative Effects

Regarding the qualitative effects expected at the time of the appraisal, these can be considered as effects at the impact level. Therefore they were evaluated in “3.3 Impact” below together with the other impacts.

### 3.3 Impact

#### 3.3.1 Intended Impacts

##### 3.3.1.1 The Reduction of Pollutants by the Sewerage Projects

At the time of the appraisal, the implementation of the project was expected to improve the quality of water flowing into the New River and the Gulf of California in Mexicali, and the quality of water flowing into the Tijuana River and the Pacific in Tijuana. The improvement in

[24] The sewage treatment plants administered by CESPT are the Porticos de San Antonio plant, the Santa Fe plant, Valle Sur plant I and Valle Sur plant II. The sewage treatment plant run by a private real estate developer is the Villa de Cedro plant. The said treatment plants administered by CESPT were developed by CESPT in the period between 2007 and 2009 as a temporary measure to be taken until the Tecolote-La Gloria plant was completed. Therefore they are not included in the project.

[25] The water analysis report published in April 2014 by an external agency accredited by the state.

water quality in this case is the reduction in BOD and SS. According to the water quality data at the monitoring points in the New River and the Tijuana River[26] obtained from CONAGUA at the time of the Ex-Post Evaluation, the targets for the BOD[27] pollution load at the discharge point were met at both monitoring points in 2012, which is two years after the project's completion[28]. With regard to the SS pollution load at the discharge point, the target for the Tijuana River was met, but the target for the New River was not met. As mentioned above, this is because the SS pollution load was already low at the discharge point in the New River at the beginning of the project (1,724 kg/day) when compared to the SS pollution load at the discharge point in the Tijuana River (24,886 kg/day). Therefore, the target for the New River was excessive. The BOD and SS pollution loads at the discharge points in both rivers have met the national standards since 2010. The treatment capacity developed by the project accounts for 8% of the total sewage treatment capacity in Mexicali and 3% in Tijuana, which are not low participation rates, therefore the project had an impact on river water quality.

Table 1: Water Quality of the New River and the Tijuana River

| Year | BOD pollution load at the discharge point (kg/day) | | SS pollution load at the discharge point (kg/day) | |
|---|---|---|---|---|
| | New River | Tijuana River | New River | Tijuana River |
| 2000 | 9,712 | 1,459 | 1,724 | 24,886 |
| 2010 The year of completion | 3,971 | 2,276 | 2,094 | 26,827 |
| 2011 One year after the project's completion | 5,329 | 1,815 | 1,930 | 11,218 |
| 2012 Two years after the project's completion | 2,188 | 1,092 | 1,542 | 5,500 |
| Target value at the time of the appraisal | 8,284 | 2,047 | 1,096 | 7,012 |
| Achievement of the target two years after the project's completion | Target achieved | Target achieved | Target not achieved | Target achieved |
| National standards | NOM001 achieved | NOM001 achieved | NOM001 achieved | NOM001 achieved |

Source: The target values are from JICA's materials given at the time of the appraisal. The actual values are all from CONAGUA.

[26] There is only one monitoring point in each river. For the both rivers, measurements are taken at the discharge points of the relay pumps which are located on the Mexican side of the border.

[27] BOD (Biochemical Oxygen Demand) is the amount of oxygen required by microbes in order to decompose organic pollutants in water. A larger value means more polluted water (source: the website of Ministry of Environment of Japan).

[28] 2010, when all the projects except for the Tecolote-La Gloria Sewage Treatment Plant were completed, was considered the year of completion.

3.3.1.2 The Improvement of the Living Conditions of the Residents in the Three Cities

At the time of the appraisal, the implementation of the project was expected to improve the hygiene and the living conditions of the local residents. To examine the impact of the project, a beneficiary survey was conducted as part of the Ex-Post Evaluation[29]. As shown in Table 2, it was confirmed that the project contributed to the improvement of residents' hygiene to a certain extent in Mexicali and Tijuana, although there were slight differences between the two cities. In Ensenada, water supply projects were excluded from the project because of the delay in the signing of the loan agreement for the project. The survey revealed that there are numerous residents in Ensenada who are dissatisfied with the water supply and that urgent measures are needed. Regarding the sewerage system in Ensenada which was subject to the project, improvements in access and services were observed. Concerning the quality of river water in the three cities, the beneficiary survey results showed no major changes in any of the cities when comparing before and after the project. Improvements in the numerical values of pollutants are not obvious by just looking the river water and therefore it is perhaps difficult for residents to recognize the change.

Table 2: Results of the Beneficiary Survey

| | |
|---|---|
| Water supply | [Access to water supply services]<br>In all three cities, all respondents answered that they already had taps within their homes or within their residential plots, and had access to water supply services before the project started (15 years ago on average in the three cities). |

[29] The details of the beneficiary survey are as follows. The survey period: January 21-31, April 27, May 1 and 4, 2014. The number of beneficiaries surveyed: 50 local residents from each city, 150 residents in total (59% were females and 41% were males. 25% were residents in their 30s, 22% were in their 40s, 21% were in their 50s, 21% were in their 60s and 11% were others). The sampling method: For all the three cities, the beneficiaries surveyed were selected through random sampling from the project's beneficiary areas. The project covers an extended area of each city and it contains many projects. Therefore, some areas were selected through consulting with the executing agencies and then the beneficiaries to be surveyed were selected through random sampling from the selected areas, in some cases. The content of the questions: Changes in the quality of drinking water and domestic water (the smell and taste); the involvement in the project; the satisfaction levels for the project; changes in health conditions; positive and negative changes caused by the project (a reduction in the burdens of tap water charges on family finances, etc.); changes in awareness about hygienic improvements and environmental conservation; whether or not there was pollution during the project's construction work (exhaust gases, waste treatment, dust, turbid water, noise or vibration); and others. Although the project did not conduct water supply development in Ensenada, the questions on water supply were also asked in Ensenada in the same way as in the other two cities, in order to obtain general opinions about water supply.

| | |
|---|---|
| | [Consumption of tap water and water-saving awareness]<br>Residents in Mexicali (which is closest to water sources and has the lowest water charges) consumed water the most. 38% of the respondents answered that they consume 21-40 $m^3$ per month on average and 34% answered that they consume 11-20 $m^3$ per month on average. In Tijuana, where residents have high water-saving awareness, 48% of the respondents answered that they consume 11-20 $m^3$ and 36% answered that they consume 10 $m^3$ or less. Although water supply development in Ensenada was excluded from this project, residents in Ensenada also answered that they consumed less water. The reasons were checked at the time of the Ex-Post Evaluation and the main reason was the serious water shortages. CESPE (Ensenada) was making efforts to resolve water shortage problems by conducting the suspension of water supply in a planned manner, while asking residents to save water further, and taking water from the Emilio López Zamora Dam for water supply. The average monthly water charges (which include sewerage service charges) paid by each household was 128 pesos in Mexicali, 110 pesos in Tijuana and 218 pesos in Ensenada. |
| | [Water supply services]<br>(1) Quality and safety of tap water: When comparing the situation before the project was implemented and the situation at the time of the beneficiary survey (January and May 2014), 92% of the respondents in Mexicali and 90% of the respondents in Tijuana answered that the quality and safety of tap water had "improved" or "greatly improved." Therefore, a major improvement in the quality and safety of tap water was observed in both cities. Only 8% of respondents in Mexicali and 10% of respondents in Tijuana answered that the quality and safety of tap water "did not improve greatly" or "worsened." The main reasons were that "the water pipes are not properly maintained" and "the water smells due to high chloride concentration." On the other hand, in Ensenada which was excluded from the water supply projects, 60% of the respondents answered that the quality and safety of tap water had "improved" or "greatly improved," and 40% of the respondents answered that the quality and safety of tap water "did not improve greatly" or "worsened." Therefore, there are clear differences between Ensenada and the other two cities. The reasons for the negative answers were because "the tap water is turbid because the water pipes and water tanks are not sufficiently maintained" and "the water smells due to high chloride concentration." |
| | (2) Opinions about the water supply service in general provided by the State Commissions for Public Services before and after the project: 91% of respondents in Mexicali and 96% of respondents in Tijuana answered that they are currently "highly satisfied" or "satisfied" with the service provided by the State Commissions for Public Services when comparing before and after the project. The reasons for the satisfaction were improved water quality, water pressure and fewer suspensions of water supply, as well as improved maintenance. In Tijuana, 33% of respondents answered that they were "able to save time thanks to the elimination of the time required to fetch water." 9% of respondents in Mexicali and 4% of respondents in Tijuana answered that they "hope to see further water quality improvement." On the other hand, in Ensenada which was excluded from the water supply projects, 60% of respondents answered that they were "satisfied" with the water supply service provided by CESPE (Ensenada) and 40% of respondents answered that they were "dissatisfied" with CESPE's service. The reasons for dissatisfaction were that there are problems with the water quality, the water pressure and the maintenance of facilities in general. |
| | (3) Effects on health: At the time of the project appraisal, people were mainly using Garrafons (purified water in 18-20 liter jugs) or bottled water for drinking, and therefore there was only a small incidence of water-derived diseases. Therefore, both in Mexicali and Tijuana, most respondents answered that there were no major changes concerning health when comparing before and after the project (96% and 91%, respectively). In Ensenada, 76% of respondents answered that there were no major changes, but 11% of respondents answered that "there had been problems of diarrhea and skin diseases, but no such problems exist now." |

| | |
|---|---|
| Sewerage projects | [Access to sewerage services]<br>100% of the respondents in Mexicali, 74% in Tijuana and 92% in Ensenada answered that the connection to public sewerage networks had improved when comparing before and after the project (they were able to connect to the networks, or they were able to have the existing deteriorated connection equipment replaced). In both Mexicali and Ensenada, all respondents answered that they have been connected to the public sewerage networks since an average of 16 to 17 years ago. On the other hand, 74% of respondents in Tijuana answered that they were able to connect to the networks gradually starting six years ago on average. Tijuana is lagging behind the other two cities regarding provision of the service, because it includes Playas de Rosarito, therefore the population growth rate was higher than in the other two cities. |
| | [Sewerage services]<br>(1) Opinions about the sewerage service in general provided by the State Commissions for Public Services before and after the project: 44% of respondents in Mexicali, 72% in Tijuana and 66% in Ensenada answered that they are currently "satisfied" with the service provided by the State Commissions for Public Services when comparing before and after the project. The reasons for the low satisfaction level in Mexicali in particular, were "there is a serious inundation problem in the rainy season due to an insufficient drainage system for rainwater (a note from the External Evaluator: rainwater drainage systems are outside the responsibility of the State Commissions for Public Services), "the sewerage networks need to be expanded," and "the commission should put more effort into environmental measures such as improving the quality of river water." In Tijuana and Ensenada, the reasons for the relative high level of satisfaction were "the sewerage projects greatly improved hygiene," and "the commissions are putting effort into water recycling." |
| | (2) Opinions about the maintenance of the sewerage networks: 76% of respondents in Mexicali, 50% in Tijuana and 73% in Ensenada answered that "the maintenance of the sewerage networks is insufficient and the inspection frequency should be increased." Respondents in the three cities thought that one of the highest priorities for the State Commissions for Public Services in the future should be "the maintenance of sewerage networks (increasing the frequency of patrols and conducting thorough maintenance including regular maintenance checkups and repairs)." |
| | (3) Changes in the water quality in rivers and other water resources: Respondents were asked to compare the turbidity, smell, floating matter and impact on the natural environment at the time of the project appraisal and at the time of the beneficiary survey. In Mexicali and Tijuana, a large percentage (70%) of the respondents answered that "there was no major improvement, but conditions had not worsened." In Ensenada, some respondents answered that conditions had "worsened" regarding floating matter such as litter, but the respondents themselves pointed out that this is an issue of awareness among the citizens. |
| | (4) Awareness about the appropriate use of sewerage systems: Respondents were asked about the appropriate use of sewerage systems by beneficiaries, for example "do not drain oil and other combustibles directly into the sewerage system," "minimize the use of detergents," and "reuse water within the household wherever possible." A large percentage of respondents answered that they have started taking the said measures within the past five years (87% in Mexicali, 93% in Tijuana and 91% in Ensenada). There was also an answer that symbolizes the fact that the area neighbors the US: a respondent who had worked in the US said, "I learned that it is important to treat water resources appropriately in the US and I have continued to take appropriate measures since returning to Mexico." |

3.3.1.3 The Improvement in the Environmental Problems concerning Mexico and the US

By the time of the project appraisal, the water pollution problem had developed into a diplomatic problem which was even discussed at a bilateral summit with the US. However, as

mentioned earlier, the water quality in the New River and the Tijuana River which run through the two countries has improved thanks to efforts made by various agencies including the IBWC. At the time of the Ex-Post Evaluation, the water quality problem was no longer a diplomatic problem for Mexico and the US.

23% of the water treated at the sewage treatment plants in Mexicali is discharged into the New River. The water quality at the monitoring point in the New River meets the national standards NOM-001-SEMARNAT-1996. With regard to the Tijuana River, by the time of the Ex-Post Evaluation, sewage which had been discharged without being treated at the time of the project appraisal was being treated at sewage treatment plants and collected at the IBWC pumping station before it was discharged into the Pacific. These sewage treatment plants included the La Morita Sewage Treatment Plant and the Monte de Los Olivos Sewage Treatment Plant which were developed by the project. The treated water met NOM-001-SEMARNAT-1996 and the quality of the Tijuana River has greatly improved. The contribution of CESPT (Tijuana) to the environmental improvement of the Tijuana River basin was recognized and it was given an official commendation by the Water Management Committee of California, the US in December 2013. Therefore, it was confirmed that the implementation of the project had a positive impact which was the improvement of the bilateral problem.

### 3.3.2 Other Impacts

#### 3.3.2.1 Impacts on the Natural Environment

Environmental impact mitigation measures were taken and monitoring was conducted during the implementation of the project by strictly observing the Baja California State Law concerning the Public Procurement of Public Works, Equipment, Materials and Services (July 7, 1998). Table 3 shows the results of the measures and the monitoring[30].

[30] At the time of the appraisal, the sewerage projects in Tijuana included the construction of the Rosarito Sewage Treatment Plant, for which impacts on neighboring residents such as noise and offensive odors were a particular concern. However, CESPT conducted the construction of the plant as a separate project, and therefore it was excluded from the Baja California Water Supply and Sanitation Project. In Mexicali and Ensenada, no environmental problems (noise, vibration, offensive odors, sludge treatment problems, etc.) have been caused by the operation of the sewage treatment plants. In Tijuana, no problems have been caused by the two treatment plants constructed by the project. However, since the Tecolote-La Gloria Sewage Treatment Plant is unfinished, the sewage that was to be treated at the plant is being temporarily treated at five other sewage treatment plants, of which three plants are located in residential districts and offensive odor problems were observed during the visits. CESPT is obtaining residents' cooperation by explaining that this is a temporary measure.

Table 3: Description of the Environmental Impact Mitigation Measures during the Project's Implementation and the Monitoring Results

| | Mitigation measures and items monitored |
|---|---|
| Exhaust gases | The project made sure that all the contractors conducted regular maintenance on construction vehicles to prevent petrol and oil leaks as well as excessive exhaust gas emissions. With the cooperation of the road traffic bureau in each city, the project also minimized indirect exhaust gas emissions by preventing congestion caused by construction work by conducting the necessary traffic controls and providing citizens with information about detours. |
| Waste treatment | The project conducted training on waste treatment for workers prior to the project's implementation. Waste was collected at the waste collection sites designated by each city municipal government and treated appropriately by type. Recycling was promoted for recyclable waste by outsourcing it to specific private businesses. Sludge was treated by sun-drying in areas designated by each city municipal government. |
| Dust | Water was sprinkled at least twice a day using water trucks to control dust. |
| Turbid water | To minimize the amount of wastewater emitted during the construction work, one temporary bio-toilet per 20 workers were introduced. Cleaning and washing the construction vehicles and equipment was outsourced. |
| Noise | The number of hours that heavy machinery which causes noise problems could be used was limited to six hours a day. The use of engine mufflers was recommended and workers were instructed to use earplugs on construction sites. There was no health damage to neighboring residents or workers, or complaints from them, according to the interviews with the executing agencies and consultants as well as the beneficiary survey. |
| Vibration | Engine mufflers were used for heavy machinery and construction work was arranged so that it would be conducted at times of the day which would minimize the impacts on neighboring residents. Similarly to "noise" above, there was no health damage to neighboring residents or workers, or complaints from them, according to the interviews with the executing agencies and consultants as well as the beneficiary survey. |

The most important positive impact on the natural environment was the recycling of water. All the State Commissions for Public Services are putting effort into the recycling of sewage. In particular, the Las Arenitas Sewage Treatment Plant (see the column for details) run by CESPM (Mexicali) and the Purple Project run by CESPT (Tijuana) are worthy of special mention. In the

Purple Project, the pipes for reusable treated water are colored in purple and the treated water is used for watering public green spaces such as parks[31]. Within the Monte de Los Olivos Sewage Treatment Plant in Tijuana which was constructed by the project, a research center for water resource recycling was established and, although small-scale, it is conducting joint studies on water recycling with the Autonomous University of Baja California[32]. At the La Morita Sewage Treatment Plant in Tijuana, water recycling is used for afforestation activities, by growing 750,000 trees for afforestation per year. At this plant, efforts are also being made to explore other possibilities for water recycling, by establishing a vineyard as part of joint research with a private business, with a view to utilizing treated water for the winery industry which is a local industry of Baja California. As shown above, each State Commission for Public Services used their own funds to add educational and research functions or facilities for promoting water recycling at the sewage treatment plants developed by the project, and succeeded in increasing the positive impacts on the environment.

Figure 2: The "Purple Project" by CESPT (Tijuana): tree nursery greenhouse at La Morita Sewage Treatment Plant

[31] CESPT has launched a website dedicated to the Purple Project in order to let people know about the project (in Spanish only: http://www.cuidoelagua.org/empapate/usoeficiente/lineamorada1.html)

[32] CESPT won the 2014 National Prize of Innovative Processes on Clean Water Supply and Sanitation (PISAPyS), an award given by the National Association of Water and Sanitation Companies of Mexico (ANEAS), for its contribution to water recycling and reuse at La Morita Sewage Treatment Plant.

**Column: The Las Arenitas Sewage Treatment Plant Run by CESPM (Mexicali)**

The Las Arenitas Sewage Treatment Plant in Mexicali was developed by the project, and is now run and maintained by CESPM (Mexicali). Some positive impacts of CESPM's activities on the natural environment have been observed in areas around the plant, and it is attracting international attention as an example of best practice.

The sewage treatment plant is situated about 23 km to the south of Mexicali. The plant started operating in March 2007. It treats about 50% of the sewage from Mexicali (the sewage treatment capacity is 840 L/s), and the beneficiary population is estimated to be about 400,000.

With the aim of complying with NOM-003-SEMARNAT-1997 and improving the natural environment in the surrounding areas, CESPM (Mexicali) started to plant aquatic plants that have water purification abilities such as Scirpus juncoides var. hotarui in 2008 and developed about 100 ha of man-made wetlands. The wetlands are not only improving water quality but also contributing to biodiversity improvement. Before the project was implemented, it was a wasteland due to the high sulfur content, but at the time of the Ex-Post Evaluation, about 130 wild bird species lived in the area including an endangered species the clapper rail (Rallus longirostris), as well as coyotes and iguanas. CESPM (Mexicali) is aiming to further develop the area into a Las Arenitas Complex which includes a nature reserve (including 120 ha of afforestation) and natural environment education facilities.


Figure 3: The Aerial View of the Las Arenitas Sewage Treatment Plant and Wetlands (provided by CESPM)

Figure 4: *Scirpus juncoides* var. *hotarui* and Wild Birds in the Wetlands (The photograph of the wild birds was provided by CESPM.)

As shown in Figure 3, the area used for the Las Arenitas Sewage Treatment Plant is wasteland, but the implementation of the project made it possible to utilize the discharged water and create wetlands. The Las Arenitas Wetlands could not have been established without the project. In addition, there is no doubt that the efforts and cooperation of CESPM (Mexicali) and other organizations after the project's completion further increased the positive impacts of the project on the natural environment. These organizations include the Border Environment Cooperation Commission (Comisión de Cooperación Ecológica Fronteriza, hereinafter referred to as COCEF), the U.S. Fish and Wildlife Service, the Secretariat of the Environment and Natural Resources, CONAGUA, NGOs such as the Sonoran Institute and Pronatura. The Las Arenitas Wetlands have been highly praised and many documentaries on the wetlands have been made[33].

[33] For example, the documentaries include Hooper Cynthia (2012) Humedales Artificiales: Three Transnational Wetlands, ARID: A Journal of Desert Art, Design and Ecology, and Redford Center "Watersheds: Exploring a New Water Ethic for the New West."

3.3.2.2 Land Acquisition and Resettlement

Table 4 shows the land acquired for the project implementation. The land to be acquired was in undeveloped areas with no residents, and therefore no resident relocation was required in any of the three cities. The law of the Baja California state government allows land acquisition for projects which are deemed to be of a public nature with high public benefits. The land for the projects was acquired appropriately.

Table 4: Details of the Land Acquisition by the Project

| | Details |
|---|---|
| Mexicali | [Plan] The area: 377.5 ha, the cost: 30,621 million pesos |
| | [Actual] The area: 654.18 ha (the number of plots: 15), the cost: as planned.<br>• The owners: Individuals, the Mexicali county government and farming communities ("ejido"). All the land plots were wasteland, which were not used for production activities or as residential sites.<br>• The acquisition process: The acquisition processes for all the land plots were completed without major problems, based on the civil law of the Baja California state. The process was as follows: (1) the Baja California state land assessment committee conducted a survey and decided on the maximum price of the land to be acquired; (2) consultations were held with the landowners in the presence of notaries and the final price was decided (the price must not exceed the maximum price); and (3) the acquired land was registered as a public asset and at the commercial registry. |
| Tijuana | [The plan] The area: about 16 ha, the cost: 30,624 million pesos |
| | [Actual] The area: 1,227.5 ha (the number of plots: 23), the cost: 51,439 million pesos<br>• The owners: The land was owned by individuals or jointly owned by ejudos, a total of 216 owners.<br>• The acquisition process: The same process as in Mexicali was used. The land plots to be acquired were wasteland, which were not used for production activities.<br>• The process for acquiring land use permission: The land use permission for laying sewer pipes in inhabited residential plots was acquired based on the Baja California state law on water services. Explanatory meetings were held for the relevant residents on the effects of the project, etc. and consultations were held on compensation. The compensation given was as follows: (1) the payment of cash, (2) the restoration of the land to its original state after the construction has been completed; (3) and permission to connect the drainpipe of the relevant household to the sewer pipe to be installed within the residential plot. Consultations with one household were prolonged, but it was agreed eventually that their drainpipe would be reallocated and the problem was solved. |

3.3.2.3 Unintended Positive/Negative Impacts

All three State Commissions for Public Services are conducting awareness raising activities explaining how the sewerage system works, its role and water recycling. For example, at the Monte de Los Olivos Sewage Treatment Plant (Tijuana) which was constructed by the project, CESPT (Tijuana) used its own funds to establish a facility next to the plant for children to experience the sewage treatment process. Visits by elementary and junior high school students

to the facility are organized regularly. Regarding awareness raising activities for businesses, promoters from CESPT (Tijuana) visit restaurants and markets and conduct awareness raising activities on the maintenance of sewer pipes in what is called the Catch Oil Program[34]. CESPM (Mexicali) introduced a joint program called the Industrial and Commercial Wastewater Monitoring Program with the state's environmental conservation bureau in 2010. The program gives businesses advice on wastewater treatment systems and treatment methods. These programs were only made possible or strengthened through the development of the sewerage infrastructure carried out by the project.

As has been seen above, this project has largely achieved its objectives. Therefore its effectiveness and impact is high.

### 3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The main changes to the outputs in each city are as follows (for details, see the annex "Comparison of the Original and Actual Scope of the Project"): In Mexicali, water treatment plants and sewage treatment plants were consolidated in order to increase the efficiency of the project, which reduced the number of water treatment plants and sewage treatment plants that need to be improved by the project. In Tijuana, the length of water pipes and the number of water meters installed slightly exceeded the plan, because the population growth rate in Playas de Rosarito covered by CESPT (Tijuana) was revised upwards., As for construction of the Tecolote- La Gloria Sewage Treatment Plant, a lawsuit between CESPT and a contractor started in 2012 and is continuing as shown in Table 5. The plant was still unfinished at the time of the Ex-Post Evaluation. In Ensenada, the biggest change was that all the projects in Ensenada were reallocated to sewerage projects because CESPE (Ensenada) decided to conduct water supply projects that were planned at the time of the project appraisal early using its own funds. All the changes explained above except for the Tecolote-La Gloria Sewage Treatment Plant were appropriate because they were made in order to respond to changes in each city's needs.

[34] The program explains how to use grease traps which prevent oil draining from the sink.

Table 5: Main Changes to the Outputs in Each City and the Reasons for the Changes

| | |
|---|---|
| Mexicali (CESPM) | |
| Water supply | • The improvement of the First Water Treatment Plant and the Ejido Nuevo León Water Treatment Plant: The improvement of the plants was excluded from the project because they were improved or expanded using CESPM's own funds before the project started, due to strong demands from residents.<br>• The improvement of the Colonia Progreso Water Treatment Plant and the Colonia Nacionalista Water Treatment Plant: In order to increase the efficiency of the project, the functions of the two plants were merged into the newly built Colonia Xochimilco Water Treatment Plant. The treatment capacity of the Colonia Xochimilco Water Treatment Plant was increased to 1,100 L/s (110% of the planned capacity).<br>• The construction of a reservoir: At the time of the appraisal, the planned capacity of the reservoir (for storing untreated water to be sent to the First and Second Water Treatment Plants) was 150,000 $m^3$, of which 80,000 $m^3$ was to be constructed by the project. However, the capacity was increased to 160,000 $m^3$ in total in case of emergencies, and it was decided that the entire reservoir would be constructed by the project. The reservoir was designed so that floating matter in the untreated water can be settled in the reservoir and the load on the water treatment plants can be reduced.<br>• With regard to the number of water meters installed, the number of meters required increased because the meters which were originally to be installed by another project were added to the project. The number therefore increased to 227% of the planned number. CESPM (Mexicali) paid for the installation of the additional meters. |
| Sewerage | • The treatment capacity of the project's sewage treatment plants was revised when INEGI revised its population growth forecast downwards in 2000. The revised treatment capacity was much lower than the planned capacity: 41% of the planned capacity for the Guadalupe Victoria Sewage Treatment Plant, 14% for the Estación Coahuila Sewage Treatment Plant, 18% for the Los Algodones Sewage Treatment Plant and 36% for the Ciudad Morelos Sewage Treatment Plant. The revised treatment capacity should enable stable sewage treatment at least until 2025 (2030 for the Ciudad Morelos Sewage Treatment Plant)35.<br>• The construction and modification of pumping stations: Some of the sewage treatment plants were to be constructed in suburbs and the treated water was to be pumped up to the water level of the New River where the treated water was to be discharged. For this purpose, six pumping stations were included in the project at the time of the appraisal, but the number was later increased to 10 (167% of the planned number. One of them was added because the Santa Isabel Sewage Treatment Plant was canceled and a pumping station was built instead). |
| Ensenada (CESPE) | |
| Water supply | • At the time of the appraisal, the water supply projects needed to be implemented urgently due to the strong needs. For this reason, when the launch of the project was delayed, CESPE (Ensenada) decided to conduct all the planned water supply projects using its own funds separately from the project. Therefore only sewerage projects were included in the project in Ensenada. |
| Sewerage | • At the time of the appraisal, the sewerage component of the project only included the construction of sewer mains, but the following projects were later added: the improvement of the El Sauzal Sewage Treatment Plant, and the development of sewer mains, sewer laterals and pumping stations in the northeastern part of Ensenada, where sewerage infrastructure development was delayed. |

[35] CESPM (Mexicali) is already considering an additional treatment capacity increase (40 L/s) of the sewage treatment plants as a response measure to a possible future increase in the amount of sewage that needs to be treated, and it has already acquired the land needed for the capacity increase.

| Tijuana (CESPT) | |
|---|---|
| Water supply | • The construction of water pipes: Because INEGI revised the population growth rate upwards for Playas de Rosarito which is covered by CESPT (Tijuana), more water pipes than planned were constructed and the length of the water pipes constructed ended up at 103% of the planned length.<br>• The construction of pumping stations: The Lázaro Cárdenas District has much steep terrain with many rocks and water has to be pumped up before it can be delivered to the beneficiaries. Therefore one more pumping station was later added to the nine pumping stations planned at the time of the appraisal.<br>• The construction of distribution reservoirs: The distribution reservoir that was planned to be constructed in the Lázaro Cárdenas District was replaced by the pumping station mentioned above. In the Ejido Matamoros District, it was determined that the existing infrastructure was sufficient and the construction of a reservoir was excluded from the project. Regarding the Maclovio Rojas Third Distribution Reservoir and two distribution reservoirs in the Tecolote District III, the landowners withdrew their decisions to sell the land before the project started. CESPT (Tijuana), which reckoned that negotiations would take some time, excluded the construction of the distribution reservoirs from the project. CESPT later constructed the Maclovio Rojas Third Distribution Reservoir using its own funds. As for the Tecolote District III, the demand for water in the area is covered by two Pan-American Distribution Reservoirs.<br>• The installation of water meters: As mentioned above, the population growth rate for Playas de Rosarito was revised upwards and therefore the number of water meters required increased. Although the cost increased to 250% of the planned cost, CESPT (Tijuana) paid for the installation of the additional meters. |
| Sewerage | • The construction of sewer mains: Due to the population increases in the areas subject to the project, more sewer mains were installed than planned. The length of sewer mains installed slightly exceeded the planned length (110% of the planned length).<br>• The construction of sewage treatment plants: Because the population growth rate was revised upwards, the treatment capacity at the La Morita Sewage Treatment Plant was slightly increased from what was planned at the time of the appraisal. The La Morita Sewage Treatment Plant and the Monte de Olivos Sewage Treatment Plant were designed so that the treatment capacity can be increased later for possible future demand increases. The Lomas de Rosarito Sewage Treatment Plant was excluded from the project due to local residents' strong demands for the early construction of the plant. The construction of the plant was launched before the project started, using CESPT's own funds and a loan from the central government. |

| | |
|---|---|
| | • The Tecolote-La Gloria Sewage Treatment Plant:<br>[Status at the time of the Ex-Post Evaluation] The contractor suspended construction work on May 18, 2010. The contractor said that the main reason for the suspension was a shortage of funds. This problem developed into a lawsuit and had not been resolved at the time of the Ex-Post Evaluation. About 21% of the construction work has been completed. While the structures of the grid chamber and the final settling tank as well as the building for the sterilization process had been completed, the oxidation ditch had not been finished. In the on-site survey, part of the reinforcing steel was exposed and corrosion was observed. Some pieces of equipment installed on site were left as they were, and four pumps were left on site with simple plastic covers on them. All the facilities and equipment were exposed to the weather. Although two guards from CESPT (Tijuana) were permanently stationed on site to prevent the equipment from being stolen, they were prohibited from modifying the construction site during the lawsuit. It is not clear to what extent the equipment would be usable even if the construction work is resumed in the future. CESPT (Tijuana) said that part of the oxidation ditch would need to be dismantled.<br>  <br>Figure 5: The Unfinished Tecolote-La Gloria Sewage Treatment Plant (at the time of the Ex-Post Evaluation) |
| | [Future measures] A future population increase is expected in the areas which were to benefit from the Tecolote-La Gloria Sewage Treatment Plant. It is clear that the existing five sewage treatment plants will not be sufficient to cover the increasing population. The Baja California state government gave clear instructions that CESPT (Tijuana) must take measures immediately. COCEF and CONAGUA support this policy. Regarding the future of the Tecolote-La Gloria Sewage Treatment Plant, CESPT (Tijuana) is considering two scenarios: (1) to complete the current plant (provided that the lawsuit is resolved); and (2) to build a new sewage treatment plant with a treatment capacity of 80 L/s. It has already submitted the basic design specifications for scenario (2) to CONAGUA. In either case, it has already been decided that the central government will lend 50% of the project cost via the Drinking Water, Sewage and Sanitation in Urban Areas Program (APAZU). The other 50% will be paid by the state government or covered by a loan. At the time of the Ex-Post Evaluation, CESPT had secured a loan from the NADB, COCEF and the Environmental Protection Agency (EPA) available until mid-2016, and the construction of Tecolote-La Gloria Sewage Treatment Plant had been included in the Construction Investment Program for Fiscal Year 2015, under which the plant is planned to conclude by latest 2016. |

### 3.4.2 Project Inputs

#### 3.4.2.1 Project Cost

The total planned project cost was 36,914 million yen (the foreign currency part was 11,180 million yen and the local currency part equaled 109 million US dollars), of which the cost subject to the Yen Loan was 22,148 million yen. The actual cost at the time of the Ex-Post

Evaluation[36] was 34,862 million yen (the foreign currency part was 21,792 million yen and the local currency part equaled 117 million US dollars), which was 94% of the planned cost.

Table 6: The Total Project Cost: Planned and Actual[*1]

| Items | | Planned costs | | | Actual costs | | | Percentage compared to the plan |
|---|---|---|---|---|---|---|---|---|
| | | Yen Loan (million yen) | Local currency (million US dollars) | Total (million yen) | Yen Loan (million yen) | Local currency (million US dollars) | Total (million yen) | |
| 1. Civil engineering work total | | 18,654 | 68 | 27,860 | 17,960 | 84 | 27,353 | 98% |
| a. The local currency part subject to the Yen Loan subtotal[*2] | | 9,135 | - | - | - | - | - | - |
| b. The foreign currency part subject to the Yen Loan subtotal | | 9,519 | - | - | 17,960 | - | - | - |
| Breakdown | Mexicali subtotal | 5,921 | | 15,990 | 10,015 | 48 | 15,222 | 95% |
| | *Out of the above, water supply* | *3,912* | - | *10,112* | *5,946* | *28* | *8,987* | *89%* |
| | *sewerage* | *2,008* | | *5,878* | *4,069* | *20* | *6,235* | *106%* |
| | Tijuana subtotal | 2,989 | | 10,850 | 6,755 | 32 | 10,307 | 95% |
| | *Out of the above, water supply* | *1,170* | - | *2,389* | *2,134* | *10* | *3,226* | *135%* |
| | *sewerage* | *1,820* | | *8,461* | *4,621* | *22* | *7,081* | *84%* |
| | Ensenada subtotal | 608 | | 1,020 | 1,190 | 6 | 1,824 | 179% |
| | *Out of the above, water supply* | *529* | - | *869* | *0* | *0* | *0* | *0* |
| | *sewerage* | *80* | | *151* | *1,190* | *6* | *1,824* | *1,208%* |
| 2. Contingencies | | 1,037 | 3 | 1,393 | 0 | 0 | 0 | - |
| 3. Consulting services | | 2,457 | 0 | 2,457 | 3,832 | 0 | 3,832 | 156% |
| 4. Land acquisition costs | | 0 | 7 | 961 | 0 | 5 | 569 | 59% |
| 5. Tax | | 0 | 31 | 4,243 | 0 | 28 | 3,108 | 73% |
| Total | | 22,148 | 109 | 36,914 | 21,792 | 117 | 34,862 | 94% |

Source: The planned cost data is from JICA's materials given at the time of the appraisal. The actual cost data is from the Baja California State Water Commission (Comision Estatal del Agua de Baja California, hereinafter referred to as CEA).

Exchange rate for the planned costs: 1 peso to 15.7 yen; the exchange rate at the time of the appraisal: 1 US dollar to 8.6 pesos (the Bank of Mexico); the price contingencies: 2.0% for the foreign currency part and 10.0% for the local currency part; the material contingencies: 5.0% for both the foreign currency part and the local currency part; the cost estimation base period: May 1998.

Exchange rate for the actual costs: 1 US dollar to 110 yen (it was decided through consultation with the executing agencies that the average value of OANDA's data on foreign exchange rates from March 2003 to January 2010 would be used.)

*1: For the planned costs, the data included a breakdown of the foreign currency part subject to the Yen Loan and the local currency part subject to the Yen Loan, but for the actual costs, the data prepared by the executing agencies only included a breakdown of the costs subject to the Yen Loan and the local currency part (unit: million dollars), therefore the above table used the latter breakdown categories for both the planned costs and the actual costs.

*2: For the planned costs, there is no data on the costs of the civil engineering work subject to the Yen Loan for each city.

[36] As mentioned above, CESPT is considering two scenarios concerning the unfinished Tecolote-La Gloria Sewage Treatment Plant (see Table 5 for details). The project cost is 1,068 million yen for scenario (1) and 180 million yen for scenario (2). Even if the cost of scenario (1) (which is higher) is included in the total project cost, the total project cost is still within the plan (97% of the planned cost).

The project cost for each city changed from the time of the appraisal due to the changes in "outputs" explained above. The main reason for the total project cost being within the plan was that all the signed contracts were in US dollars and the US dollar weakened against the yen. When looking at the project cost for each city, the project cost for Tijuana was within the plan. In Mexicali, the plan at the time of the appraisal was revised into a more cost-effective plan by consolidating water treatment plants and changing the size of each sewage treatment plant in accordance with the population growth rate, as explained above. This resulted in a much lower project cost than in the plan. In Ensenada, the project cost was 179% of the planned cost, because the improvement of the El Sauzal Sewage Treatment Plant and the development of pumping stations were added to the project, among others. The project costs were determined to be appropriate considering the changes in the "outputs" and the effects of the exchange rates.

3.4.2.2 Project Period

The planned project period at the time of the appraisal was from March 2000 to December 2004 (57 months). The actual project period was from March 2000 to May 2014, which is when the Ex-Post Evaluation was conducted (171 months, 300% of the planned period), because the Tecolote-La Gloria Sewage Treatment Plant is unfinished.

Table 7: Project Period: Planned and Actual

| Process | Planned (at the time of the appraisal) | Actual | Percentage compared to plan |
|---|---|---|---|
| L/A signing date | March 2000 | March 2000 | - |
| Consulting services | March 2000 - December 2004<br>57 months | June 2001 - January 2010<br>104 months | 182% |
| The project period | March 2000 - December 2004<br>57 months | March 2000 - May 2014*<br>171 months | 300% |
| Mexicali | | | |
| Bidding procedures | June 2000 - March 2001<br>9 months | November 2000 - March 2003<br>29 months | 322% |
| The development of water supply networks | January 2001 - September 2003<br>33 months | September 2002 - March 2006<br>43 months | 130% |
| The development of sewerage networks | January 2001 - December 2004<br>48 months | October 2002 - December 2006<br>57 months | 119% |
| Water treatment plants | April 2001 - December 2003<br>21 months | December 2003 - September 2007<br>46 months | 219% |
| Sewage treatment plants | April 2001 - December 2003<br>21 months | April 2004 - February 2008<br>47 months | 224% |
| Tijuana | | | |
| Bidding procedures | June 2000 - March 2001<br>9 months | November 2000 - October 2004<br>48 months | 533% |
| The development of water supply networks | January 2001 - September 2003<br>33 months | November 2002 - May 2008<br>67 months | 203% |
| The development of sewerage networks | January 2001 - September 2003<br>33 months | September 2003 - October 2010<br>70 months | 212% |
| Sewage treatment plants* | April 2001 - December 2002<br>21 months | November 2005 - Unfinished as of May 2014<br>(Plants other than the Tecolote-La Gloria Sewage Treatment Plant were completed in October, 2010.)<br>103 months | 490% |
| Ensenada | | | |
| Bidding procedures | June 2000 - December 2000<br>6 months | November 2000 - December 2003<br>38 months | 633% |
| The development of sewerage networks, etc. | January 2001 - December 2002<br>24 months | July 2004 - March 2008<br>45 months | 188% |

* The actual project period was considered to be up to May 2014 which is when the Ex-Post Evaluation was conducted, because the Tecolote-La Gloria Sewage Treatment Plant is unfinished.

The main reasons for the delay are as follows.

a. The launch of the project was delayed because it took time to select a consultant[37]. As the launch of the project was postponed, residents' demands for the prompt development of many components increased and each executing agency developed these components using their own funds, as explained above. Therefore, the project developed other components.

b. The implementation of the "Tijuana Bid Package 7" was greatly delayed. The package included the Tecolote-La Gloria Sewage Treatment Plant, the La Morita Sewage Treatment Plant and the Monte de Los Olivos Sewage Treatment Plant. The contractor for the package extended the completion date of the work for the package three times for various reasons

[37] The companies which came second and third in the bidding filed complaints because the company which conducted the Special Assistance for Project Formation (SAPROF) for the project was selected as a consultant and this infringed state law. The state government then invalidated the selection process. However, the state government's legal affairs bureau issued a ruling in April 2001 that the selection process and results were valid because the yen loan project procurement guidelines override state law for yen loan contracts.

including a significant delay in the launch of the detailed designing process, changes to the designs which occurred after the detailed designing was launched, and difficulties in securing labor. Then, in May 2010, it pulled out its workers and heavy machinery and abandoned the construction work, saying that the main reason for the suspension was a shortage of funds. CESPT (Tijuana) repeatedly requested that the contractor resume the construction work, but due to lack of developments, CESPT canceled the contract with the company in April 2012. This problem later developed into lawsuits in the district court and the federal financial and administrative court of law. The lawsuit was still ongoing at the time of the Ex-Post Evaluation. For the projects in Mexicali and Tijuana (including Playas de Rosarito), detailed designs had to be revised because INEGI revised the population forecast downwards for Mexicali and upwards for Tijuana.

c. The bid price for the development of sewerage networks in Tijuana greatly exceeded the expected price, and therefore the bidding had to be conducted again.

d. Hurricane Katrina, which occurred in 2005, delayed the delivery of materials that were to be imported from the US, and the development work for water supply and sewerage networks in Mexicali and Tijuana was delayed.

As mentioned above, the main reason why the project period was 300% compared to plan is specifically due to the fact that the Tecolote-La Gloria Sewage Treatment Plant is unfinished, which resulted in a decrease in the efficiency of the project. The fact that the said sewage treatment plant is unfinished because of a lawsuit (developed into a lawsuit in April 2012) is a matter that has to be solved urgently between the Executing Agency and the contractor.

This project consists of a series of subprojects conducted in several cities. In reference to the bid package in which the Tecolote-La Gloria Sewage Treatment Plant was included, as a result of the site visit conducted by JICA's representative office in 2007, especially the said plant was considered as requiring a close attention of its progress speed after starting construction, and that the construction progress rate was low. In Japanese ODA loan projects, it is true that primarily Executing Agency is the main entity responsible for the implementation of a project, and that a Consultant assists with the management of the project's progress. However, when it is clear that a subproject is experiencing a delay, before it develops into a lawsuit, a detailed monitoring of the factors that could affect the progress of the subproject could have been conducted. Project monitoring plans indicating specific actions towards correcting the course of the project could have been discussed and agreed upon between JICA, BANOBRAS (the borrower) and related entities of the subprojects, that is, CEA and CESPT (Tijuana) which was the executing agency in this case. Such actions could have been effective.

3.4.3 Results of Calculations of Internal Rates of Return (Reference only)

At the time of the appraisal, the financial internal rate of return (FIRR) was only calculated for Mexicali and Tijuana (18.9% and 23.68%, respectively)[38]. At the time of the Ex-Post Evaluation, calculation of the FIRR was not possible because accurate data on the operation and maintenance costs, investment costs, etc. for the facilities developed by the project was not available.

As has been seen above, although the project cost was within the plan, the project period exceeded the plan. Therefore efficiency of the project is fair.

**3.5 Sustainability (Rating: ②)**

3.5.1 Institutional Aspects of Operation and Maintenance

Each State Commission for Public Services is responsible for the operation and maintenance of infrastructure after the completion of the project[39]. Both CESPM (Mexicali) and CESPT (Tijuana) are led by Directorate Generals and each commission is comprised of four sub-directorates: the Water Supply and Sewerage Sub-directorate, the Service Sub-directorate, the Project and Construction Sub-directorate and the Administrative Sub-directorate. The Water Supply and Sewerage Sub-directorate is responsible for the operation and maintenance of water treatment plants and sewage treatment plants, and the Service Sub-directorate is responsible for the operation and maintenance of the water mains network and the sewer pipe network. The institutional structure for the operation and maintenance is clear and there is no problem of personnel shortages. CESPE (Ensenada) is comprised of the Administrative and Financial Sub-directorate, the Service Sub-directorate and the Technical Sub-directorate, and the Technical Sub-directorate has the water supply department and the sewerage department. As shown in Table 8, the percentage of personnel directly engaged in the operation and maintenance of water supply and sewerage infrastructure is 47% at CESPM (Mexicali), 52% at CESPT (Tijuana) and 36% at CESPE (Ensenada). In the interviews with workers on site, many workers said that, at CESPE (Ensenada), “there are personnel shortages and maintenance work cannot catch up with the needs,” while there is no shortage in the institutional structure for the operation and maintenance of infrastructure at CESPM (Mexicali) and CESPT (Tijuana).

[38] The costs used for the calculation at the time of the appraisal were the project investment costs and the operation and maintenance costs (expenditures for water and sewage treatment, maintenance costs, expected uncollected charges, wages and general administrative expenses). The income sources used for calculation were the income from service charges (a 10% revision of service charges per year was expected) and other income sources (1% of the income from service charges was expected). A project life of 26 years was used.

[39] The Baja California State Water Commission (CEA) coordinated between the executing agencies and served as a contact point with JICA during the project implementation. At the time of the Ex-Post Evaluation, CEA was also responsible for the creation of the water supply and sewerage infrastructure plan for the entire Baja California area and the coordination between State Commissions for Public Services. CEA was understood to be a “supervisor” at the time of the appraisal, but in reality it was a “coordinator” which did not have any decision making authority concerning the content, postponement, etc. of the project.

Table 8: Institutional Structure for the Operation and Management of Facilities at Each State Commission for Public Services (2013)

| Department | CESPM (Mexicali) | CESPT (Tijuana) | CESPE (Ensenada) |
|---|---|---|---|
| Operation of water treatment plants | 84 people | 440 people | 27 people |
| Operation of sewage treatment plants | 85 people | | 43 people |
| General maintenance | 47 people | | 13 people |
| Operation and maintenance of water mains | 174 people | 449 people | 67 people |
| Operation and maintenance of sewer pipes | 157 people | | 40 people |
| Total | 547 people | 889 people | 190 people |
| Total number of employees | 1,165 people | 1,692 people | 525 people |

Source: CESPM (Mexicali), CESPT (Tijuana) and CESPE (Ensenada)

The water treatment plants of CESPM (Mexicali) are controlled at the headquarters via the remote control system[40]. CESPT (Tijuana) has been outsourcing the operation and maintenance of the La Morita Treatment Plant and the Monte de Olivos Treatment Plant constructed by the project to a French-owned private company since 2012. Regarding the maintenance of water mains and sewer pipe networks in Mexicali and Tijuana, cities are divided into districts and each district has a dedicated maintenance team. In Ensenada, although there are 11 teams that maintain the water mains for the entire city, during the on-site survey, many workers on site said that the personnel shortages are preventing appropriate maintenance. The water research center was established within CEA and a technical assessment team made up of personnel from each State Commission for Public Services was formed. The team conducts detailed assessment of several water treatment plants and sewage treatment plants every year and gives recommendations on what should be improved and how. The team then conducts monitoring on the improvement progress one year later, in order to strengthen the monitoring of and the institutional structure for the operation and maintenance of infrastructure in the entire water supply and sewerage sector of Baja California.

As has been seen above, there are personnel shortages at CESPE (Ensenada), while both CESPM (Mexicali) and CESPT (Tijuana) have appropriate institutional structures for the operation and maintenance of water supply and sewerage facilities. Therefore there are some problems with the institutional aspects of the operation and maintenance system.

3.5.2 Technical Aspects of Operation and Maintenance

With regard to the technical aspects of the operation and maintenance of infrastructure, the Ex-Ante Evaluation results reported that the number of staff members who are experienced in

[40] The remote control system for sewage treatment plants will be introduced in 2014.

maintenance was particularly small in CESPM (Mexicali), but it was discovered in the Ex-Post Evaluation that the staff members in the water supply and sewerage sector have been employed for long enough when looking at the average number of years of employment.

Table 9: Technical Levels of the Staff Members Involved in the Operation and Maintenance of Infrastructure (December 2013)

| | University graduates or higher education<br>Average years of experience | Clerical staff<br>Average years of experience | Engineers<br>Average years of experience | Non-engineers<br>Average years of experience | Subtotal | Total number of employees |
|---|---|---|---|---|---|---|
| CESPM (Mexicali) | 72 people<br>15 years | 28 people<br>17 years | 160 people<br>16 years | 287 people<br>13 years | 547 people | 1,165 people |
| CESPE (Ensenada) | 18 people<br>9 years | 3 people<br>25 years | 46 people<br>9 years | 123 people<br>15 years | 190 people | 525 people |
| CESPT (Tijuana) | 89 people<br>11 years | 43 people<br>6 years | 725 people<br>14 years | 32 people<br>4 years | 889 people | 1,692 people |

Source: CESPM (Mexicali), CESPT (Tijuana) and CESPE (Ensenada)

CESPM (Mexicali) has the most advanced maintenance system. It has a database for the procedures and check sheets for daily inspections and preventive maintenance[41] for each type of equipment. The database is updated constantly. A detailed maintenance program is created every fiscal year and a budget is allocated to the program. Corrective maintenance is often conducted for deteriorating water mains. CESPM (Mexicali) is also putting effort into quality control: it has introduced an internal evaluation system for the operation teams to evaluate the maintenance teams. All three State Commissions for Public Services keep the maintenance manuals of each equipment manufacturer. CESPM (Mexicali) and CESPT (Tijuana) were conducting periodic maintenance and preventive maintenance in accordance with the manuals. The on-site survey revealed that CESPE (Ensenada) was not necessarily able to follow the manuals for maintenance and also the maintenance in general was delayed, resulting in more corrective maintenance than preventive maintenance. This is because CESPE has not been able to improve its technical levels for maintenance due to personnel shortages and the financial situation explained later.

With regard to personnel development for the operation and maintenance of infrastructure, all three State Commissions for Public Services conduct training programs, but their levels differ. CESPM (Mexicali) has the most advanced programs. In order to improve quality control, it has a corporate target of increasing the number of qualified workers engaged in water supply and sewerage services who are certified by the US California Department of Public Health and the California Water Environment Association. For that, CESPM supports its workers by both

[41] Preventive maintenance refers to systematic maintenance conducted before equipment, machinery, etc. malfunctions or deteriorates. Corrective maintenance mentioned later refers to the repair of equipment and machinery after malfunction has occurred.

providing in-house training and by sending them to external training organizations. As for CESPT (Tijuana), it provided training programs in and out of the institution during 2013 on "water leakage investigation and repair of water mains," "on-site workers' safety management," etc. in-house and at other organizations. It plans to conduct 68 training programs in total in 2014, including "5S in maintenance," "water analysis" and "hydraulics." Similarly, CESPE (Ensenada) conducted 10 training programs in-house and at other organizations in 2013, including "operation indicators for water supply and sewerage systems," "the maintenance of water mains networks" and "the reuse of water resulting from sewage treatment." However, the number of programs and the content are insufficient for improving maintenance technical levels. As a future measure, CESPT (Ensenada) said that it wants to support non-engineers who have 10 years or more of experience in obtaining qualifications[42].

As has been seen above, it was confirmed that all three State Commissions for Public Services kept maintenance manuals, and it was also confirmed from maintenance records that CESPM (Mexicali) and CESPT (Tijuana) conducted maintenance appropriately by following the manuals. However, CESPE (Ensenada) has not been able to engage in the technical improvement of maintenance and its maintenance work is being delayed due to personnel shortages and its financial situation as explained later. Its technical levels for maintenance are clearly lagging behind when compared to the facilities and equipment of CESPM (Mexicali) and CESPT (Tijuana), and there is room for improvement.

### 3.5.3 Financial Aspects of Operation and Maintenance

When looking at the financial information for the past four years obtained at the time of the Ex-Post Evaluation, revenues from water charges collected by CESPT (Tijuana) and CESPE (Ensenada) are increasing in general, but they are not enough to cover the operational and maintenance costs. The fee collection rate is increasing in general at CESPT (Tijuana), but the rate fluctuates in a range between 70% and less than 90% at CESPM (Mexicali) and CESPT (Tijuana) and there is no significant improvement. The government has a compensation system for sewage treatment plants which comply with national water quality standards[43], but it is not

[42] During the implementation of the project, as part of the consulting services, training was conducted by the National Hydraulic Engineering Institute of Mexico for all three State Commissions for Public Services. However, it was reported that the training did not lead to technical improvements because its content was general and did not take into account the water environment in Baja California. Furthermore, a total of six people participated in the training "The FY 2009 Project for Supporting Capacity Building for Improving the Sustainability of Development Effects concerning Yen-loan Projects in the Water Supply and Sewerage Sectors in Latin America" which was conducted in Japan from January 12 to February 5, 2010. However, only three ex-participants are still working at the executing agencies (two at CESPM (Mexicali) and one at CESPT (Tijuana)). At CESPM (Mexicali), the training content is being utilized by the ex-participants putting what they learned in Japan into practice. At CESPT (Tijuana) and CESPE (Ensenada), it was reported that "knowledge did not accumulate within the organizations." Concerning how to select the participants for the training in Japan, many people said that "JICA's opinions should be more influential in order to ensure that personnel who have the potential to be useful in the future will be selected, because participants are not selected objectively within the executing agencies in many cases."

[43] CONAGUA pays a subsidy of 0.5 pesos per $m^3$ of treated water.

enough to cover interest on loans or depreciation costs, and the State Commissions for Public Services continue to operate at a loss. In Mexico, there is a fundamental idea that "access to water is the right of all citizens" and the suspension of water supply due to unpaid bills is prohibited by law. Therefore, the future challenge is how citizens' ideas can be changed and paying for services can be made the norm[44].

[44] Each State Commission for Public Services is conducting awareness raising activities and taking measures to resolve the problem of non-payment (such as offering discounts for those who pay in advance), in order to increase the fee collection rate. CESPM (Mexicali) and others are making efforts to improve business management, for example to earn income by offering a water quality analysis service and training service to private businesses and State Commissions for Public Services in other states. The new governor who took office in November 2013 implemented a "cancellation program" for unpaid water supply and sewerage charges from January to April 2014. The program cancels all the unpaid water charges for the period from 2007 to 2012 and allows people to pay unpaid water charges for 2013 in installments. In exchange, all the residents in the state should be committed to paying future water charges by the deadlines. However, similar programs have been implemented by past administrations and the effectiveness of the program as an economic incentive is not clear.

Table 10: Financial Situation at Each State Commission for Public Services

(Unit: million pesos)

| | 2010 | 2011 | 2012 | 2013 | Financial status |
|---|---|---|---|---|---|
| **CESPM (Mexicali)** | | | | | |
| [Income] | | | | | • Until 2012, CESPM was the only executing agency in the project that was able to cover maintenance costs including labor costs with the income from water charges. However, it is operating at a loss mainly due to the payment of interest and depreciation costs. The fee collection rate has been decreasing in general since 2011.<br>• Because of the above-explained financial situation, the rating company Fitch Ratings revised the rating for CESPM downwards from A to A- (in the system used in Mexico) in August 2013. It still considers that the default risk is low. |
| Water charges | 845 | 870 | 956 | 873 | |
| Others | 83 | 112 | 103 | 47 | |
| Subtotal (A) | 928 | 982 | 1,059 | 920 | |
| [Expenditure] | | | | | |
| Operation and maintenance costs*1 | 716 | 755 | 877 | 927 | |
| Others | 372 | 374 | 358 | 350 | |
| Subtotal (B) | 1,088 | 1,129 | 1,235 | 1,277 | |
| (A) - (B) | -160 | -147 | -176 | -375 | |
| Fee collection rate*2 | 83% | 88% | 83% | 74% | |
| **CESPT (Tijuana)** | | | | | |
| [Income] | | | | | • At CESPT, the operation and maintenance costs have been larger than the income from water charges for the three years from 2010 to 2012. Therefore, CESPT has been operating at a loss. However, income from water charges is increasing every year and the deficits are decreasing in general.<br>• Fitch Ratings continued to rate CESPT as A in the Mexican system in October 2013. |
| Water charges | 1,633 | 1,746 | 1,895 | 2,023 | |
| Others | 295 | 276 | 413 | 313 | |
| Subtotal (A) | 1,928 | 2,022 | 2,308 | 2,336 | |
| [Expenditure] | | | | | |
| Operation and maintenance costs*1 | 1,694 | 2,088 | 2,028 | 2,058 | |
| Others | 172 | 144 | 434 | 395 | |
| Subtotal (B) | 1,866 | 2,232 | 2,462 | 2,453 | |
| (A) - (B) | 62 | -210 | -154 | -117 | |
| Fee collection rate*2 | 71% | 67% | 70% | 72% | |
| **CESPE (Ensenada)** | | | | | |
| [Income] | | | | | • CESPE has been operating at a loss for the past four years. In 2012, the income from water charges increased to the point where it can just about cover the operation and maintenance costs.<br>• Fitch Ratings continued to rate CESPE as BB in the Mexican system in October 2013. |
| Water charges | 302 | 329 | 368 | 391 | |
| Others | 29 | 28 | 3 | 4 | |
| Subtotal (A) | 331 | 357 | 371 | 395 | |
| [Expenditure] | | | | | |
| Operation and maintenance costs*1 | 331 | 343 | 365 | 388 | |
| Others | 63 | 73 | 78 | 57 | |
| Subtotal (B) | 394 | 416 | 443 | 445 | |
| (A) - (B) | -63 | -59 | -72 | -50 | |
| Fee collection rate* | 81% | 78% | 81% | 77% | |

Source: The financial statements are from CESPM (Mexicali), CESPT (Tijuana) and CESPE (Ensenada). The data on fee collection rates is from CEA.

*1: Including the labor costs

*2: The fee collection rate = (the amount collected in the relevant fiscal year ÷ the amount billed in the relevant fiscal year) × 100.

Water charges are categorized into domestic[45], commercial, industrial and public. The sewerage charges are categorized into charges for households and others. The charges are calculated based on the investment costs for water supply and sewerage development and the maintenance costs for the developed infrastructure. They are then announced in an official gazette. The state ordinance stipulates that the charges can be revised upwards only within the inflation rate announced by the Bank of Mexico every year. As an exception, the state ordinance also allows a special increase in charges (including an increase exceeding the inflation rate) where necessary, such as for recovering investment. However, according to interviews with the State Commissions for Public Services, the charges to be applied from January 2014 only increased by 5%, while in reality a 25% increase was needed. Therefore the level of charges continues to put pressure on their operations.

As explained above, all three State Commissions for Public Services have been operating at a loss, and therefore concern remains about the financial sustainability of their operation and maintenance systems.

### 3.5.4 Current Status of Operation and Maintenance

The following explains the situation for the operation and maintenance of the facilities and equipment in each city at the time of the Ex-Post Evaluation. Equipment and machinery other than the ones which are pointed out to be malfunctioning and unrepaired below are all working and being run properly.

CESPM (Mexicali)

- Water treatment plants: Regarding the Second Water Treatment Plant, there were leaks in the water pipes connecting to two distribution reservoirs. At the time of the on-site survey, the repair work was in progress and was expected to be completed by the end of 2014.
- Sewage treatment plants: The amount of water flowing into the treatment plants decreased due to an increase in citizens' water-saving awareness, and this increased BOD in the sewage at the treatment plants. As a measure to treat the increased load, more anaerobic chambers and aerators will be installed at the Zaragoza Sewage Treatment Plant using the FY 2015 budget.

CESPT (Tijuana)

- The La Morita Sewage Treatment Plant and the Monte de Los Olivos Sewage Treatment Plant: Because the sand separators are getting worn away, the maintenance manual will be altered and preventive maintenance will be conducted more frequently. At the time of the Ex-Post Evaluation, the fans were being replaced.

[45] Tap water charges and sewerage charges are not separated in the bills. The sewerage charges account for about 40% of the total charges.

CESPE (Ensenada)

- The El Sauzal Sewage Treatment Plant: The sludge collector in the settling tank was unbalanced and the accumulated sludge that has settled in the tank cannot be removed properly. The settling tank was planned to be emptied in March 2014 in order to replace the collector, but a budget could not be secured and it has not been replaced.
- Pumping stations: The emergency generator at the relay pumping station in the northeastern part of Ensenada had broken down and has not been repaired. At the IMSS Pumping Station, the sand separator control system and the vortex pump need to be replaced and the flowmeter needs to be repaired, but they have not been done due to delays in obtaining spare parts. At the majority of pumping stations, the salt tolerance coating maintenance is being delayed and sea breezes are corroding the outer surface of the water pipes. The maintenance of coarse screens is also being delayed. The obtainment of spare parts is being delayed at CESPE (Ensenada) due to various problems, for example parts have not been purchased for over one year due to a lack of funds although purchase requests have been submitted, and parts have not been delivered due to the manufacturers' circumstances.

At the time of the Ex-Post Evaluation, there were no major problems in the operation and maintenance at CESPM (Mexicali) and CESPT (Tijuana). The necessary repairs and the obtainment and replacement of spare parts have already been done or are included in the maintenance plan for the next fiscal year. With regard to CESPE (Ensenada), there were problems concerning the obtainment of spare parts and maintenance was not being conducted as planned, due to budget shortages and insufficient human resources (both in terms of institutional structure and technical levels) as explained above. Unrepaired equipment and machinery were seen in various places at CESPE's facilities.

As has been seen above, some minor problems have been observed in terms of the institutional, technical and financial aspects of the maintenance system for the project as well as the current status of the operation and maintenance of the project. Therefore sustainability of the project effect is fair.

## 4. Conclusion, Lessons Learned and Recommendations

### 4.1 Conclusion

This project aimed to solve water pollution problems by developing the water supply and sewerage infrastructure of three cities in Baja California, namely Mexicali, Tijuana and Ensenada.

This project was in line with the development plans of the Mexican government and the Baja California state government and their development needs as well as with Japan's ODA

policy at the times of the appraisal and the Ex-Post Evaluation. Therefore its relevance is high. All the operation and effect indicators for water supply and sewerage systems have improved greatly in each city. The targets set at the time of the appraisal were achieved or the values are improving steadily. Although the water supply and sewerage project in Tijuana includes the unfinished Tecolote-La Gloria Sewage Treatment Plant, CESPT (Tijuana) constructed temporary small-scale sewage treatment plants using its own funds and it is providing a partial service. Therefore, the sewerage development project in Tijuana has been effective despite the delay in the development of the Tecolote-La Gloria Sewage Treatment Plant. The External Evaluator found evidence of project effects including a reduction in river water pollution, an improvement in the residents' living conditions, an improvement in environmental problems concerning Mexico and the US and the reuse of treated sewage by CESPM (Mexicali) and CESPT (Tijuana). Therefore the project's effectiveness and impact is high. Although the project cost was within the plan, the project period has significantly exceeded the plan because the Tecolote-La Gloria Sewage Treatment Plant is unfinished. Therefore the efficiency of the project is fair. Some problems have been observed in terms of the financial aspects of the operation and maintenance system administered by the State Commissions for Public Services in all three cities. Some problems have also been observed in terms of the technical aspects of the operation and maintenance system administered by CESPE (Ensenada). Therefore sustainability of the project effect is fair.

In light of the above, this project is evaluated to be satisfactory.

## 4.2 Recommendations

### 4.2.1 Recommendations to the Executing Agencies

- CESPT (Tijuana): Because the Tecolote-La Gloria Sewage Treatment Plant is unfinished, there is a delay in the improvement of the relevant residents' living conditions and there are also negative impacts on the natural environment such as the fact that about 50% of the sewage from the relevant area is discharged into a river without being treated. CESPT (Tijuana) has already formulated two detailed plans for the measures to be taken, however, it is desirable that it takes urgent decisions and develops the necessary sewage treatment facility.
- CESPE (Ensenada): It is desirable that CESPE improves its management policy, institutional structure for maintenance, and its technical level to similar levels such as CESPM (Mexicali) and CESPT (Tijuana), and provides a more stable water supply and sewerage services to the citizens. Regarding the water supply system which was excluded from the project due to the delay in the launch of the project, there are problems such as the interruption of water supply, as well as water quality problems. CESPE needs to formulate

and implement specific plans on the measures to be taken and state when they will be put into action in order to solve these problems in the future.

- All the three State Commissions for Public Services: Regarding the problems stated in "3.5.4 Current Status of Operation and Maintenance," it is desirable that the three commissions make sure that countermeasures to these problems will be included in future budgets and maintenance programs, and take urgent measures. In addition, in light of the results of the beneficiary survey, it is necessary to conduct the water treatment process thoroughly and also to improve the maintenance and implementation systems for the water mains and sewer pipe networks.

4.2.2 Recommendations to JICA

- Regarding CESPT (Tijuana) Tecolote-La Gloria Sewage Treatment Plant, after consulting and agreeing with CESPT (Tijuana), JICA should continuously check the progress of Plant. For that, the following future measures must be taken: JICA should indicate that both CESPT (Tijuana) and JICA are both accountable, and request CESPT (Tijuana) to submit a progress report, as well as the "Monitoring Sheet" which will be provided to CESPT (Tijuana) together with this Ex-Post Evaluation Report, once every two months for instance.
- The discharge of water from sewage treatment plants in desert areas is an important issue for many countries. Therefore, it is desirable to introduce the efforts made at the Las Arenitas Wetlands to a wider population as an example of best practice.

### 4.3 Lessons Learned

**Appropriate Monitoring of Projects that are Experiencing Delays**

The "Tijuana Bid Package 7" which included the unfinished Tecolote-La Gloria Sewage Treatment Plant (see 3.4.2.2 Project Period for details) was identified for having problems already since 2007. In ODA loan projects that are large in size and take longer time, it is important to also conduct periodical site visits of subprojects, and also to have agreements on detailed project monitoring procedures, not only with the executing agency but also with the entities in charge of subprojects.

Especially, when it is possible to see that a particular subproject might be delayed for a long period, it is desirable that JICA conducts discussions not only with the executing agency, but also with the entities in charge of the subproject and the consultants, in order to agree on specific project monitoring plans including possible scenarios that can be foreseen in the future and what actions will be taken by when. In projects that have particular problems, such as the case of the unfinished construction site of this project, it is desirable to collect information not only from the executing agency, but also directly from the entities that are overseeing the construction and managing that particular subproject. In addition, sharing knowledge on

measures that were taken in similar problems (regarding project and contract management etc.) of other JICA projects in other countries[46], so that operation departments and overseas representative offices can use these to analyze and solve project management problems, is also an idea worth considering.

End

[46] In similar ODA loan projects that resulted in delayed project periods due to unfinished construction works, there have been cases where the contract was completely canceled when the contractor suspended construction works, or as a way of avoiding the cancellation of the contract, supplementary clauses were added to the contract so that part of the implementation of the project would be transferred to the executing agency. These measures have minimized impacts on the whole project as a result.

[Annex I] Operation and Effect Indicators

A. Water Supply Projects: Operation and Effect Indicators[*1]

| | Benchmark value 1999 | Target value at completion | 2007 | 2008 Completion Year[*2] | 2009 One year after project completion | 2010 Two years after project completion[*2] | 2011 | 2012 | 2013 | Target achievement rate two years after project completion |
|---|---|---|---|---|---|---|---|---|---|---|
| Operation indicators | | | | | | | | | | |
| Population supplied with water (10,000 people)[*3] | | | | | | | | | | |
| • Mexicali | 59.8 | 79.8 | 68.8 | 70.6 | 75.2 | 76.7 | 78.5 | 80.4 | 82.3 | 96% |
| • Tijuana | 115.2 | 131.2 | 147.9 | 163.2 | 168.4 | 174.2 | 172.5 | 181.4 | 187.8 | 133% |
| • Ensenada | - | - | 27.6 | 28.8 | 28.2 | 28.8 | 29.9 | 29.9 | 31.7 | - |
| Amount of water supplied (million $m^3$/year) | | | | | | | | | | |
| • Mexicali | 101.7 | Not set | 84.4 | 85.7 | 86.7 | 80.1 | 82.6 | 85.9 | 85.9 | Stagnating |
| • Tijuana | 100.3 | | 110.5 | 111.3 | 109.7 | 105.8 | 110.1 | 117.8 | 114.2 | Slightly decreased |
| • Ensenada | - | | 21.8 | 21.6 | 21.6 | 21.7 | 22.3 | 22.7 | 21.9 | - |
| Percentage of non-revenue water[*4] (%) | | | | | | | | | | |
| • Mexicali | 28% | 25% or less | 14% | 17% | 17% | 13% | 14% | 16% | 16% | Achieved |
| • Tijuana | 27% | 20% or less | 19% | 20% | 20% | 19% | 21% | 19% | 19% | Achieved |
| • Ensenada | 27% | 20% or less | 20% | 19% | 19% | 21% | 21% | 21% | 17% | - |
| Water quality (turbidity/NTU) | | | | | | | | | | |
| • Mexicali | - | National | 0.53 | 0.40 | 0.41 | 0.49 | 0.47 | 0.49 | 0.43 | Achieved |
| • Tijuana | 1.5 | standards: | 0.47 | 0.53 | 0.54 | 0.63 | 0.57 | 0.51 | 0.38 | Achieved |
| • Ensenada | 1.0 | <1.0 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 | 0.96 | 0.98 | - |
| Effect indicators | | | | | | | | | | |
| Water supply coverage (%) | | | | | | | | | | |
| • Mexicali | 97% | 100% | 99.2% | 99.3% | 99.3% | 99.4% | 99.5% | 99.6% | 99.7% | 99.4% (at least 80% achieved) |
| • Tijuana | 88% | 97% or more | 93.4% | 97.5% | 98.7% | 98.9% | 98.0% | 99.1% | 98.7% | 102% |
| • Ensenada | 94.2% | Not set | 97.4% | 97.8% | 98.5% | 98.6% | 98.6% | 98.6% | 99.4% | - |

B. Sewerage Projects: Operation and Effect Indicators[*5]

| | Benchmark value 1999 | Target value at completion | 2007 | 2008 | 2009 | 2010[*6] Completion year | 2011 One year after project completion | 2012 Two years after project completion | 2013 | Target achievement rate two years after project completion |
|---|---|---|---|---|---|---|---|---|---|---|
| Operation indicators | | | | | | | | | | |
| Population receiving sewage treatment service (10,000 people) | | | | | | | | | | |
| • Mexicali | 51.0 | Not set | 65.5 | 67.5 | 71.9 | 73.3 | 75.0 | 76.8 | 78.6 | Increasing steadily |
| • Tijuana | 71.0 | | 156.3 | 145.7 | 151.3 | 157.0 | 155.2 | 163.9 | 169.3 | |
| • Ensenada | NA | | 24.2 | 26.9 | 26.5 | 27.1 | 27.8 | 29.0 | 29.7 | |
| Amount of sewage treated (million $m^3$)/year | | | | | | | | | | |
| • Mexicali | 37.5 | Not set | 50.2 | 55.5 | 57.0 | 55.9 | 56.3 | 57.7 | 57.8 | Increasing steadily |
| • Tijuana | NA | | 75.6 | 64.6 | 75.8 | 76.3 | 82.1 | 81.3 | 82.5 | |
| • Ensenada | NA | | 14.5 | 15.7 | 16.6 | 16.9 | 17.6 | 17.8 | 17.9 | |
| Effect indicators | | | | | | | | | | |
| Sewerage system coverage (%) | | | | | | | | | | |
| • Mexicali | 89% | 97% | 94.4% | 95.0% | 94.9% | 95.0% | 95.1% | 95.2% | 95.3% | 98% (at least 80% achieved) |
| • Tijuana | 61% | 85% | 80.5% | 87.1% | 88.7% | 89.1% | 88.2% | 89.6% | 89.3% | 105% |
| • Ensenada | 71% | 80% | 85.6% | 91.3% | 92.5% | 92.7% | 91.7% | 93.2% | 93.4% | 116% |
| Amount of reused water resulting from sewage treatment (million $m^3$/year) | | Not set | | | | | | | | |
| • Mexicali | 0 | | 13.4 | 14.3 | 43.0 | 40.4 | 41.8 | 45.5 | 45.4 | Increasing in general |
| • Tijuana | 0 | | 2.3 | 2.5 | 3.7 | 3.2 | 3.8 | 4.1 | 4.5 | Increasing in general |
| • Ensenada | 0 | | 0.6 | 0.6 | 0.5 | 0.2 | 0.1 | 0.2 | 0.2 | Mostly unchanged |

Source: The planned values are from JICA's materials given at the time of the appraisal. The actual values are from each State Commission for Public Services and CEA.

*1: Water supply projects were not conducted in Ensenada. Therefore the indicators shown above are for reference only.

*2: "The year of completion" for the water supply projects is 2008 which is when all the projects in Mexicali and Tijuana were completed. The evaluation was conducted for 2010 (two years after the project's completion) onwards.

*3: The materials for internal use state that the target value for the additional population supplied with water should be 200,000 people in Mexicali and 160,000 people in Tijuana, but they were not clearly defined as indicators nor was the benchmark fiscal year. Therefore, in the Ex-Post Evaluation, the benchmark year was set to be 1999 and the target value at the time of the project completion was set to be the sum of the population supplied with water in 1999 and the additional population supplied with water mentioned above.

*4: The percentage of non-revenue water = (The amount of water which did not become subject to the collection of charges) ÷ (the amount of water supplied) × 100

*5: For the income from water charges and the fee collection rate, please see "3.5.3 Financial Aspects of Operation and Maintenance" in "3.5 Sustainability."

*6: The year of completion for the sewerage projects was considered to be 2010 which is when all the sewerage infrastructure developments in the three cities were completed except for the Tecolote-La Gloria Sewage Treatment Plant. The evaluation was conducted for 2012 (two years after the project's completion).

## [Annex II] Operation Indicators for Each Water Treatment Plant and Sewage Treatment Plant

| | Actual | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 Year of completion of water supply projects | 2009 | 2010 Year of completion of sewerage projects | 2011 | 2012 | 2013 |
| **CESPM (Mexicali)** | | | | | | | | | |
| **Water Supply Projects** | | | | | | | | | |
| Xochimilco Water Treatment Plant (Treatment Capacity: 1,100 l/s) | | | | | | | | | |
| Population Served (1000 persons) | — | — | 96,886 | 150,671 | 154,069 | 157,543 | 161,096 | 164,736 | 168,448 |
| Amount of Water Supply ($m^3$/day) | — | — | 31,043 | 54,049 | 53,373 | 47,249 | 43,388 | 47,807 | 50,092 |
| Facility Utilization Rate (%) | — | — | 27% | 23% | 47% | 40% | 40% | 40% | 44% |
| Water Treatment Plant No. 2 (Treatment Capacity: Approx. 2,750 l/s) | | | | | | | | | |
| Population Served (1000 persons) | 388,518 | 397,280 | 406,239 | 481,255 | 492,108 | 503,206 | 514,554 | 526,180 | 538,037 |
| Amount of Water Supply ($m^3$/day) | 125,307 | 119,071 | 130,163 | 153,942 | 144,183 | 135,449 | 148,349 | 152,002 | 156,743 |
| Facility Utilization Rate (%) | 73% | 69% | 55% | 65% | 60% | 56% | 62% | 63% | 72% |
| **Sewerage Projects** | | | | | | | | | |
| Las Arenitas Sewage Treatment Plant (Treatment Capacity: Approx. 840 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | — | — | 55,717 | 61,281 | 59,233 | 64,207 | 66,111 | 68,392 | 72,032 |
| Facility Utilization Rate (%) | — | — | 77% | 84% | 82% | 86% | 91% | 94% | 99% |
| BOD Reduction Rate (%) | — | — | 75% | 77% | 73% | 78% | 81% | 80% | 78% |
| SS Reduction Rate (%) | — | — | 75% | 74% | 60% | 94% | 82% | 81% | 70% |
| Guadalupe Victoria Sewage Treatment Plant (Treatment Capacity: Approx. 70 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | — | — | 1,963 | 2,301 | 2,275 | 1,501 | 2,523 | 2,904 | 2,878 |
| Facility Utilization Rate (%) | — | — | 3% | 38% | 38% | 37% | 42% | 48% | 47% |
| BOD Reduction Rate (%) | — | — | — | 85% | 87% | 96% | 90% | 92% | 92% |
| SS Reduction Rate (%) | — | — | — | 58% | 78% | 75% | 77% | 65% | 76% |
| Estacion Coahuila Sewage Treatment Plant (Treatment Capacity: Approx. 20 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | — | — | — | 295 | 798 | 768 | 730 | 763 | 832 |
| Facility Utilization Rate (%) | — | — | — | 17% | 46% | 48% | 42% | 44% | 48% |
| BOD Reduction Rate (%) | — | — | — | — | 82% | 89% | 93% | 95% | 95% |
| SS Reduction Rate (%) | — | — | — | — | 44% | 97% | 44% | 31% | 40% |
| Los Algodones Sewage Treatment Plant (Treatment Capacity: Approx. 20 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | — | — | 523 | 513 | 558 | 623 | 468 | 750 | 1,278 |
| Facility Utilization Rate (%) | — | — | 30% | 19% | 32% | 39% | 27% | 43% | 74% |
| BOD Reduction Rate (%) | — | — | — | 87% | 78% | 95% | 88% | 90% | 88% |
| SS Reduction Rate (%) | — | — | 31% | 47% | 51% | 98% | 68% | 64% | 31% |
| Ciudad Morelos Sewage Treatment Plant (Treatment Capacity: Approx. 30 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | — | 615 | 1,113 | 1,040 | 1,230 | 1,302 | 1,352 | 1,418 | 1,547 |
| Facility Utilization Rate (%) | — | 24% | 43% | 40% | 47% | 50% | 52% | 55% | 60% |
| BOD Reduction Rate (%) | — | 32% | 55% | 91% | 87% | 82% | 83% | 89% | 84% |
| SS Reduction Rate (%) | — | 13% | 63% | 71% | 76% | 68% | 73% | 73% | 27% |
| Colonia Zaragoza Sewage Treatment Plant (Treatment Capacity: 1,300 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | 68,447 | 67,040 | 68,661 | 66,856 | 71,758 | 69,750 | 69,789 | 68,449 | 65,726 |
| Facility Utilization Rate (%) | 61% | 59% | 61% | 59% | 64% | 62% | 62% | 61% | 59% |
| BOD Reduction Rate (%) | — | 38% | 25% | 17% | 80% | 16% | 23% | 26% | 31% |
| SS Reduction Rate (%) | — | 54% | 44% | 23% | 75% | 25% | 29% | 40% | 32% |
| **CESPT (Tijuana)** | | | | | | | | | |
| **Sewerage Projects** | | | | | | | | | |
| Monte de Olivos Sewage Treatment Plant (Treatment Capacity: Approx. 340 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | — | — | — | — | 11,698 | 17,589 | 18,774 | 15,965 | 16,735 |
| Facility Utilization Rate (%) | — | — | — | — | 29% | 44% | 47% | 43% | 42% |
| BOD Reduction Rate (%) | — | — | — | — | 98% | 99% | 99% | 98% | 97% |
| SS Reduction Rate (%) | — | — | — | — | 99% | 99% | 99% | 99% | 97% |
| La Morita Sewage Treatment Plant (Treatment Capacity: 254 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | — | — | — | — | — | 2,814 | 6,769 | 10,839 | 14,636 |
| Facility Utilization Rate (%) | — | — | — | — | — | 13% | 31% | 50% | 67% |
| BOD Reduction Rate (%) | — | — | — | — | — | 98% | 99% | 97% | 96% |
| SS Reduction Rate (%) | — | — | — | — | — | 98% | 99% | 99% | 98% |
| Tecolote la Gloria Sewage Treatment Plant: Not completed thus no data is available | | | | | | | | | |
| **CESPE (Ensenada)** | | | | | | | | | |
| **Sewerage Project** | | | | | | | | | |
| El Sauzal Sewage Treatment Plant (Treatment Capacity: 120 l/s) | | | | | | | | | |
| Amount of waste water treated ($m^3$/day) | 3,024 | 2,791 | 3,370 | 2,851 | 2,877 | 2,419 | 2,765 | 2,903 | 2,889 |
| Facility Utilization Rate (%) | 29% | 27% | 33% | 28% | 28% | 23% | 27% | 28% | 27% |
| BOD Reduction Rate (%) | 95% | 95% | 94% | 96% | 94% | 97% | 98% | 97% | 97% |
| SS Reduction Rate (%) | 94% | 94% | 94% | 96% | 95% | 95% | 97% | 94% | 95% |

Source: CESPM (Mexicali), CESPT (Tijuana), CESPE (Ensenada).

# [Annex III] Effect Indicators: Quality of the Water Discharged from Sewage Treatment Plants

| Name of Sewage Treatment Plant | National Standard NOM-001-SEMARNAT-1996 | Actual | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 Completion Year | 2011 One year after completion | 2012 Two years after completion | 2013 Three years after completion |
| **CESPM (Mexicali)** | | | | | | | | | | |
| Las Arenitas Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | — | — | 1,607 | 1,178 | 886 | 934 | 1,238 | 1,100 | 1,228.90 |
| BOD Concentration (mg/l) | 75 | — | — | 79 | 52 | 41 | 39 | 51 | 43 | 42.8 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | — | — | 7 | 4 | 3 | 3 | 3 | 3 | 731.8 |
| COD Concentration (mg/l) | 250 | — | — | 253 | 213 | 169 | 192 | 184 | 171 | 161.1 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | — | — | 6 | 5 | 4 | 5 | 4 | 4 | 311.1 |
| SS Concentration (mg/l) | 75 | — | — | 61 | 57 | 63 | 67 | 55 | 64 | 65.7 |
| | Achieved | | | | | | | | | |
| $NH_3$-N (Ammoniac Nitrogen) mg/l | — | — | — | 31 | 22 | 22 | 25 | 21 | 26 | 27.3 |
| Total Nitrogen (T-N) mg/l | 40 | — | — | 40 | 31 | 32 | 31 | 31 | 36 | 36.2 |
| | Achieved | | | | | | | | | |
| Total Phosphorus (T-P) mg/l | 30 | — | — | 9 | 7.53 | 5.21 | 2.96 | 5.44 | 5.76 | 5.7 |
| | Achieved | | | | | | | | | |
| pH (Range) | 10-5 | — | — | 8 | 8.31 | 8.38 | 8.43 | 8.22 | 8.12 | 8.29 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | — | — | 5,722 | 3,895 | 102 | 240 | 756 | 971 | 239.9 |
| | Achieved | | | | | | | | | |
| Guadalupe Victoria Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | — | — | 120 | 23 | 21 | 14 | 15 | 15 | 21.9 |
| BOD Concentration (mg/l) | 75 | — | — | 167 | 27 | 25 | 24 | 16 | 14 | 13.7 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | — | — | 24 | 2 | 1 | 2 | 1 | 1 | 35.8 |
| COD Concentration (mg/l) | 250 | — | — | 398 | 165 | 159 | 193 | 165 | 123 | 178 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | — | — | 29 | 3 | 3 | 4 | 2 | 2 | 7.5 |
| SS Concentration (mg/l) | 75 | — | — | 200 | 56 | 44 | 51 | 39 | 39 | 37 |
| | Achieved | | | | | | | | | |
| $NH_3$-N (Ammoniac Nitrogen) mg/l | — | — | — | 35 | 27 | 33 | 36 | 39 | 36 | 40 |
| Total Nitrogen (T-N) mg/l | 40 | — | — | 44 | 36 | 40 | 46 | 46 | 43 | 45.6 |
| | Achieved | | | | | | | | | |
| Total Phosphorus (T-P) mg/l | 30 | — | — | 7.82 | 7.81 | 6.53 | 7.23 | 6.55 | 6.45 | 7.02 |
| | Achieved | | | | | | | | | |
| pH (Range) | 10-5 | — | — | 7.4 | 8.26 | 8.13 | 7.97 | 8.08 | 7.94 | 8.14 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | — | — | 20,920,000 | 44 | 132 | 91 | 17 | 12 | 5.3 |
| | Achieved | | | | | | | | | |
| Estacion Coahuila Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | — | — | — | 0.49 | 8 | 7 | 3 | 2 | 3.2 |
| BOD Concentration (mg/l) | 75 | — | — | — | 4.51 | 26 | 25.3 | 11.46 | 6.9 | 5.4 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | — | — | — | 0.14 | 2 | 2 | 1 | 0.43 | 7.1 |
| COD Concentration (mg/l) | 250 | — | — | — | 87 | 206 | 198 | 203 | 171 | 144.3 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | — | — | — | 1 | 5 | 5 | 6 | 6 | 5.8 |
| SS Concentration (mg/l) | 75 | — | — | — | 16 | 69 | 63 | 76 | 99 | 60.7 |
| | Achieved | | | | | | | | | |
| $NH_3$-N (Ammoniac Nitrogen) mg/l | — | — | — | — | 31 | 22 | 16 | 22 | 22 | 24.9 |
| Total Nitrogen (T-N) mg/l | 40 | — | — | — | 35 | 28 | 23 | 31 | 32 | 31.4 |
| | Achieved | | | | | | | | | |
| Total Phosphorus (T-P) mg/l | 30 | — | — | — | 10 | 6.34 | 4.8 | 5.41 | 6.15 | 5.2 |
| | Achieved | | | | | | | | | |
| pH (Range) | 6-10 | — | — | — | 7.88 | 8.41 | 8.47 | 8.25 | 8.13 | 8.1 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | — | — | — | 3 | 16 | 61 | 88 | 3.38 | 102.7 |
| | Achieved | | | | | | | | | |
| Los Algodones Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | — | — | 10 | 4 | 8 | 4 | 3 | 4 | 10.7 |
| BOD Concentration (mg/l) | 75 | — | — | 53 | 19 | 37 | 19 | 19 | 15 | 12.8 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | — | — | 2 | 1 | 3 | 1 | 1 | 1 | 13.3 |
| COD Concentration (mg/l) | 250 | — | — | 120 | 134 | 189 | 151 | 162 | 140 | 165.7 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | — | — | 2 | 3 | 4 | 3 | 4 | 2 | 116 |
| SS Concentration (mg/l) | 75 | — | — | 57 | 59 | 58 | 60 | 59 | 45 | 57.3 |
| | Achieved | | | | | | | | | |
| $NH_3$-N (Ammoniac Nitrogen) mg/l | — | — | — | 10 | 16 | 18 | 16 | 22 | 24 | 30 |
| Total Nitrogen (T-N) mg/l | 40 | — | — | 15 | 22 | 25 | 23 | 29 | 31 | 39.8 |
| | Achieved | | | | | | | | | |
| Total Phosphorus (T-P) mg/l | 30 | — | — | 2.99 | 4.5 | 3.92 | 2.96 | 4.15 | 5.09 | 5.3 |
| | Achieved | | | | | | | | | |
| pH (Range) | 6-10 | — | — | 8 | 8.23 | 8.23 | 8.19 | 8 | 7.74 | 7.83 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | — | — | 410,000 | 12 | 5 | 318 | 36 | 70 | 26.7 |
| | Achieved | | | | | | | | | |
| Ciudad Morelos Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | — | 33 | 65 | 7 | 14 | 12 | 11 | 8 | 12 |
| BOD Concentration (mg/l) | 75 | — | 149 | 160 | 18 | 30 | 24 | 22 | 14 | 20 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | — | 19 | 25 | 1 | 2 | 1 | 1 | 1 | 0.8 |
| COD Concentration (mg/l) | 250 | — | 347 | 434 | 165 | 143 | 143 | 143 | 103 | 115 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | — | 15 | 21 | 3 | 2 | 2 | 2 | 1 | 0.4 |
| SS Concentration (mg/l) | 75 | — | 115 | 132 | 56 | 47 | 44 | 37 | 34 | 60 |
| | Achieved | | | | | | | | | |
| $NH_3$-N (Ammoniac Nitrogen) mg/l | — | — | 36 | 33 | 26 | 22 | 28 | 36 | 34 | 36 |
| Total Nitrogen (T-N) mg/l | 40 | — | 7 | 40 | 35 | 29 | 34 | 43 | 40 | 42 |
| | Achieved except 2011 and 2013 | | | | | | | | | |
| Total Phosphorus (T-P) mg/l | 30 | — | 9.85 | 7.66 | 7.53 | 5.52 | 5.32 | 4.15 | 5.56 | 6 |
| | Achieved | | | | | | | | | |
| pH (Range) | 6-10 | — | 7.8 | 7.4 | 8.45 | 7.99 | 8.01 | 7.97 | 8.01 | 7.95 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | — | 12,750,000 | 19,380,000 | 47 | 82 | 67 | 14 | 9 | 31 |
| | Achieved | | | | | | | | | |

| Name of Sewage Treatment Plant | National Standard NOM-001-SEMARNAT-1996 | Actual | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 Completion Year | 2011 One year after completion | 2012 Two years after completion | 2013 Three years after completion |
| **CESPM (Mexicali)** | | | | | | | | | | |
| Colonia Zaragoza Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | — | 2,104 | 1,353 | 1,001 | 1,231 | 917 | 1,070 | 350 | 336 |
| BOD Concentration (mg/l) | 75 | — | 86 | 54 | 41 | 47 | 36 | 4 | 14 | 14 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | — | 5,407 | 4,135 | 4,490 | 5,133 | 5,091 | 5,094 | 2,573 | 2,758 |
| COD Concentration (mg/l) | 250 | — | 221 | 165 | 184 | 196 | 200 | 200 | 103 | 115 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | — | 1,908 | 1,578 | 1,122 | 1,440 | 1,145 | 1,171 | 849 | 983 |
| SS Concentration (mg/l) | 75 | — | 78 | 63 | 46 | 55 | 45 | 46 | 34 | 41 |
| | Achieved | | | | | | | | | |
| $NH_3$-N (Ammoniac Nitrogen) mg/l | — | — | 26 | 27 | 24 | 28 | 27 | 30 | 34 | 36 |
| Total Nitrogen (T-N) mg/l | 40 | — | 37 | 35 | 40 | 37 | 36 | 39 | 40 | 42 |
| | Achieved except 2013 | | | | | | | | | |
| Total Phosphorus (T-P) mg/l | 30 | — | 8.91 | 8 | 6.86 | 6.97 | 5.85 | 6.25 | 5.56 | 6.01 |
| | Achieved | | | | | | | | | |
| pH (Range) | 6-10 | — | 8.3 | 8.2 | 8.19 | 8.08 | 8.19 | 8.1 | 8.01 | 7.9 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | — | 550,000 | 30,000 | 62 | 9 | 55 | 325 | 10 | 31 |
| | Achieved | | | | | | | | | |
| **CESPT (Tijuana)** | | | | | | | | | | |
| Monte de Olivos Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | — | — | — | — | 29.9 | 32.7 | 37.7 | 43.6 | 35.4 |
| BOD Concentration (mg/l) | 75 | — | — | — | — | 7 | 5.1 | 5.5 | 7.49 | 5.8 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | — | — | — | — | 175.1 | 242 | 223.4 | 190.6 | 185.7 |
| COD Concentration (mg/l) | 250 | — | — | — | — | 41 | 37.7 | 32.6 | 32.72 | 30.4 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | — | — | — | — | 29.9 | 39.8 | 36.3 | 30.7 | 30.7 |
| SS Concentration (mg/l) | 75 | — | — | — | — | 7 | 6.2 | 5.3 | 5.28 | 5.02 |
| | Achieved | | | | | | | | | |
| NH3-N (Ammoniac Nitrogen) mg/l | 40 | — | — | — | — | 5 | 13.8 | 29.4 | 18.9 | 28.9 |
| | Achieved | | | | | | | | | |
| PO4-P (phosphate-phosphorus) mg/l | 30 | — | — | — | — | 5 | 14.8 | 6.5 | 4.9 | 8.84 |
| | Achieved | | | | | | | | | |
| pH (Range) | 6-10 | — | — | — | — | 7.4 | 7.4 | 7.4 | 7.32 | 7.08 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | — | — | — | — | 223 | 175 | 697 | 890 | 239 |
| | Achieved | | | | | | | | | |
| La Morita Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | — | — | — | — | — | 9 | 13.3 | 49.5 | 40.8 |
| BOD Concentration (mg/l) | 75 | — | — | — | — | — | 8.8 | 5.38 | 12.5 | 7.64 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | — | — | — | — | — | 67.6 | 96.6 | 165 | 228.9 |
| COD Concentration (mg/l) | 250 | — | — | — | — | — | 65.8 | 39 | 41.7 | 42.85 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | — | — | — | — | — | 8.3 | 13 | 21.6 | 31.19 |
| SS Concentration (mg/l) | 75 | — | — | — | — | — | 8 | 5.28 | 5.46 | 5.84 |
| | Achieved | | | | | | | | | |
| NH3-N (Ammoniac Nitrogen) mg/l | 40 | — | — | — | — | — | 27.2 | 31.2 | 27.6 | 24.25 |
| | Achieved | | | | | | | | | |
| PO4-P (phosphate-phosphorus) mg/l | 30 | — | — | — | — | — | 4.9 | 6.7 | 7 | 7.3 |
| | Achieved | | | | | | | | | |
| pH (Range) | 6-10 | — | — | — | — | — | 7.65 | 7.43 | 7.33 | 7.24 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | — | — | — | — | — | 910 | 436 | 329 | 132.5 |
| | Achieved | | | | | | | | | |
| Tecolote la Gloria Sewage Treatment Plant | | | | | | | | | | |
| **CESPE (Ensenada)** | | | | | | | | | | |
| El Sauzal Sewage Treatment Plant | | | | | | | | | | |
| BOD Emission Volume (Ton/year) | — | 18 | 14 | 21 | 11 | 14 | 8 | 10 | 10 | 10.75 |
| BOD Concentration (mg/l) | 75 | 16 | 14 | 17 | 11 | 13 | 9 | 10 | 9 | 10.4 |
| | Achieved | | | | | | | | | |
| COD Emission Volume (Ton/year) | — | 56 | 58 | 76 | 47 | 41 | 37 | 46 | 55 | 77.47 |
| COD Concentration (mg/l) | 250 | 51 | 57 | 62 | 45 | 39 | 42 | 46 | 52 | 74.9 |
| | Achieved | | | | | | | | | |
| SS Emission Volume (Ton/year) | — | 14 | 13 | 17 | 11 | 14 | 12 | 10 | 16 | 14.9 |
| SS Concentration (mg/l) | 75 | 13 | 13 | 14 | 11 | 13 | 14 | 10 | 15 | 14.41 |
| | Achieved | | | | | | | | | |
| Total Nitrogen (T-N) mg/l | 40 | 5.83 | — | — | 16 | 14.41 | 15.65 | 14.69 | 10.6 | 12.95 |
| | Achieved | | | | | | | | | |
| Total Phosphorus (T-P) mg/l | 30 | 7.64 | — | — | 4.4 | 6.51 | 6.22 | 7.03 | 5.09 | 5.93 |
| | Achieved | | | | | | | | | |
| pH (Range) | 6-10 | 7 | 6.9 | 7.2 | 7.1 | 7.2 | 7.2 | 7.2 | 7.3 | 7 |
| | Achieved | | | | | | | | | |
| Number of Coliform Bacteria (MPN/100ml)\ | 2000 | 776 | — | — | 278 | <3 | <3 | <34 | 36 | <3 |
| | Achieved | | | | | | | | | |

Source: CESPM (Mexicali), CESPT (Tijuana), CESPE (Ensenada).

## Comparison of the Original and Actual Scope of the Project

| Item | Original | Actual |
|---|---|---|
| (1) Project Outputs | | |
| [Mexicali] | | |
| I. Water supply projects | | |
| a. Newly built Water Treatment Plants (WTP) | | |
| • Colonia Xochimilco WTP | Treatment capacity: 1,000 L/s | Treatment capacity: 1,100 L/s |
| b. Improved or extended | | |
| • Colonia Progreso WTP | Treatment capacity: approx. 67 L/s | Merged into Colonia Xochimilco WTP |
| • The First WTP | Treatment capacity: approx. 1,250 L/s | Excluded |
| • The Second WTP | Treatment capacity: approx. 2,200 L/s | Treatment capacity: approx. 2,750 L/s |
| • Ejido Nuevo León WTP | Treatment capacity: approx. 35 L/s | Excluded |
| • Colonia Nacionalista WTP | Treatment capacity: approx. 60 L/s | Merged into Colonia Xochimilco WTP |
| • Construction of a reservoir for untreated water | 1 reservoir<br>Capacity: approx. 80,000 $m^3$ | 1 reservoir<br>Capacity: approx. 160,000 $m^3$ |
| • Construction of water mains | 82 km | 99 km |
| • Installation of water meters | Approx. 22,000 units | 50,000 units |
| II. Sewerage projects | | |
| a. Newly built Sewage Treatment Plants(STP) | | |
| • Las Arenitas STP | Treatment capacity: approx. 840 L/s | As planned |
| • Guadalupe Victoria STP | Treatment capacity: approx. 170 L/s | Treatment capacity: approx. 70 L/s |
| • Estación Coahuila STP | Treatment capacity: approx. 140 L/s | Treatment capacity: approx. 20 L/s |
| • Los Algodones STP | Treatment capacity: approx. 110 L/s | Treatment capacity: approx. 20 L/s |
| • Santa Isabel STP | Treatment capacity: approx. 195 L/s | Canceled |
| • Ciudad Morelos STP | Treatment capacity: approx. 110 L/s | Treatment capacity: approx. 30 L/s |
| b. Improved or extended | | |
| • Colonia Zaragoza STP | Treatment capacity: approx. 1,300 L/s | As planned |
| • Construction and improvement of arterial sewer mains | Approx. 31 km | As planned |
| • Construction and improvement of branch sewer mains networks | Approx. 183 km | As planned |
| • Construction and improvement of pumping stations | 6 stations | 10 stations |
| [Tijuana] | | |
| I. Water supply projects | | |
| (All newly built) | | |
| • Construction of water mains | Approx. 353 km | 362 km |
| • Construction of pumping stations | 9 stations | 10 stations |
| • Construction of distribution reservoirs | 15 reservoirs | 11 reservoirs (The one in Lázaro Cárdenas was replaced by a pumping station) |
| • Installation of water meters | 23,372 units | 58,513 units |
| • Installation of taps for individual households | 31,000 units | 167 units |
| II. Sewage projects | | |
| (All newly built) | | |
| • Monte de Olivos STP | Treatment capacity: approx. 340 L/s | As planned (can be increased to 460 L/s) |
| • Lomas de Rosarito STP | Treatment capacity: approx. 75 L/s | Excluded |
| • Tecolote-La Gloria STP | Treatment capacity: approx. 100 L/s | Unfinished (Planned treatment capacity: 120 L/s, |

| | | |
|---|---|---|
| • La Morita STP | Treatment capacity: approx. 150 L/s | construction progress rate: 20.92%)<br>254 L/s<br>(can be increased to 380 L/s) |
| • Construction of pumping stations | 2 stations | As planned |
| • Construction of public sewer laterals | 76 km | 41 km |
| • Construction of sewer mains | Approx. 627 km | 692 km |
| [Ensenada]<br>I. <u>Water supply projects</u><br>• Construction of pumping stations | 3 stations | - |
| • Construction of water pipes from water treatment plants to distribution facilities | Approx. 4.4 km | - |
| • Construction of distribution tanks | 3 tanks | - |
| • Installation of arterial water mains | Approx. 24 km | - |
| • Construction of water mains networks | Approx. 21 km | |
| II. <u>Sewerage projects</u><br>a. Newly built<br>• Construction of arterial sewer mains | 6.5 km | 6.11 km |
| • Construction of public sewer laterals | - | 13.11 km |
| • Construction of branch sewer mains networks | - | 33.77 km |
| • Construction of pumping stations | - | 3 stations |
| b. Improved or extended<br>• Improvement of El Sauzal STP | - | Treatment capacity was increased from 60 L/s to 120 L/s |
| • Construction and improvement of pumping stations | - | 1 station |
| (2) Project Period | March 2000 - December 2004<br>(57 months) | March 2000 - May 2013<br>(171 months)<br>Note: The time when the Ex-Post Evaluation was conducted was used because part the project is unfinished. |
| (3) Project Cost<br>Amount paid in Foreign currency<br>Amount paid in Local currency | 11,180 million yen<br>25,734 million yen<br>(190 million US dollars) | 21,792 million yen<br>13,070 million yen<br>(117 million US dollars) |
| Total<br>Japanese ODA loan portion<br>Exchange rate | 36,914 million yen<br>22,148 million yen<br>1 peso = 15.7 yen<br>(As of May 1998) | 34,862 million yen<br>21,792 million yen<br>1 US dollar = 110 yen<br>(Average between March 2003 and January 2010)<br>Source: OANDA |

Federative Republic of Brazil

Ex-post Evaluation of Japanese Technical Cooperation Project

The Project for Capacity Development on Non-Revenue Water Control

External Evaluators: Yuko Kishino and Noriaki Suzuki, IC Net Limited

## 0. Summary

The project was conducted with the aim of developing human resources and creating the systems needed to reduce non-revenue water at the Sanitation Company of the State of Sao Paulo (hereinafter "SABESP"), in order to achieve the stable supply of water in the State of Sao Paulo.

Non-revenue water control has been one of the highest priority issues in the state which has a large population and scarce water resources. The project is also in line with the Brazilian development plan which aims at the effective utilization of water resources. Therefore, the project's relevance is high. There were some problems regarding the project implementation systems such as the insufficient number of local coordinators deployed. Nonetheless, technology transfer through on-the-job training (hereinafter "OJT") promoted communication between engineers and administrators, and led to non-revenue water control at the pilot areas. However, there were only limited activities to disseminate the output obtained at the pilot areas to the rest of SABESP's service area, and this negatively affected the Project Purpose achievement level. On the other hand, SABESP strengthened its non-revenue water control based on the output obtained at the pilot areas. As a result, the Overall Goal is expected to be achieved. Therefore, the effectiveness/impact of the project is fair. Although the project period and the elements of inputs were mostly within the plan, the project cost slightly exceeded the plan. Therefore, the efficiency of the project is fair. SABESP is the largest business entity in Latin America with the fully equipped business implementation system and a high level of technology. It has good financial standing and is expected to allocate a budget for non-revenue water control into the future. Therefore, the sustainability of the project effects is high.

In light of the above, this project is evaluated to be satisfactory.

## 1. Project Description


Project Locations

Pipe locating activity at a pilot area

### 1.1 Background

The State of Sao Paulo has the largest urban area in South America. It has a population of 40 million, which accounts for 21.5% of the total population of Brazil (2005). However, it has only 1.6% of the total water resources in Brazil (1999), and the efficient utilization and conservation of limited water resources is the highest priority issue. SABESP, which is the implementing agency of the project, is one of the largest public water supply and sewerage companies in the world. It supplies drinking water to 368 municipalities in the state[1]. Since it created the leakage control program for the State of Sao Paulo in 1981, it has been working on the streamlining of water supply system operations, particularly the minimization of leakages from water supply networks. Since 2000[2], the Japan International Cooperation Agency (hereinafter "JICA") has been dispatching Short-Term Experts to SABESP and giving advice on the formulation and implementation of the non-revenue water reduction plans. As a result, it was confirmed that company-wide measures are needed in order for SABESP to strengthen non-revenue water control including leakage control measures and to achieve a reduction in the Non-Revenue Water Rate. In response, in July 2005, the Brazilian government requested technical cooperation from the Japanese government (which has a high level of non-revenue water control technology) with the aim of improving SABESP's non-revenue water control abilities. After the dispatch of the preliminary study mission in October 2006, the three-year Project for Capacity Development on Non-Revenue Water Control was launched in July 2007[3].

### 1.2 Project Outline

| | | |
|---|---|---|
| Overall Goal | | Water supply will be stabilized by reduction of Non-Revenue Water (NRW) in service areas of SABESP. |
| Project Objective | | The capacity of SABESP's staff to control NRW is strengthened. |
| Outputs | Output 1 | The SABESP staff who are involved in the Project understand the significance of NRW control, and the system for the human resources development is strengthened. |
| | Output 2 | Fundamental measures for NRW control[4] are strengthened through practice in the pilot areas. |
| | Output 3 | Corrective measures for NRW control[5] are strengthened through practice in the pilot areas. |
| | Output 4 | Preventive measures for NRW control[6] are strengthened through practice in the pilot areas. |

[1] This accounts for about 15% of the population supplied with water in Brazil.
[2] 2000, 2001 and 2003.
[3] The Record of Discussion (R/D) was signed in March 2007.
[4] They refer to advance preparations for non-revenue water control, including the identification of the components of non-revenue water in the water supply service area and formulating control measures.
[5] They refer to measures to tackle currently occurring problems which cause the occurrence of non-revenue water, e.g., the identification of leaking spots and measures to stop leakages from identified spots.
[6] They refer to measures to prevent the occurrence of non-revenue water, such as leakages from old water mains and service pipes, leakages caused by unnecessarily high water pressure during the night, and leakages caused by inappropriate construction work.

| | |
|---|---|
| Inputs | Japanese Side:<br>1. 10 Experts<br>One for Long-Term, nine for Short-Term<br>2. 50 counterpart trainees received in Japan<br>3. Zero trainees for third-country training programs (total)<br>4. Equipment: 35.4 million yen<br>5. Cost of the operation in Brazil: 24.4 million yen<br>Brazilian Side:<br>1. Deployment of counterparts<br>2. Purchase of office equipment<br>3. Transport costs, per diems and accommodation costs<br>4. Land and facilities, project office, utilities<br>5. Budget allocation for NRW control works in the pilot areas, counterpart salary, seminars |
| Total cost | 362 million yen |
| Period of Cooperation | July 19, 2007 - July 18, 2010 |
| Implementing Agency | Sanitation Company of the State of Sao Paulo (SABESP) |
| Cooperation Agencies in Japan | The Ministry of Health, Labour and Welfare, the Saitama City Waterworks Bureau, and the Kawasaki City Waterworks Bureau |
| Related Projects | • Non Revenue Water Control Project in Sao Paulo State (Loan) (Loan Agreement (L/A): 2012)<br>• Sanitation Improvement Project for Baixada Santista Metropolitan Region (Loan) (L/A: 2004)<br>• Water Sector Project in the State of Sao Paulo (World Bank) (1989-1993)<br>• Guarapiranga River Basin Environmental Sanitation Project (World Bank) (1993–2000)<br>• Project of the Tietê River Decontamination (Inter-America Development Bank) (1992–2008)<br>• Water Sector Project in the State of Sao Paulo (Inter-America Development Bank) (1996 onwards) |

[The Non-Revenue Water Volume (Rate)]

As shown in Figure 1 below, the International Water Association (hereinafter the “IWA”) defines the Non-Revenue Water Rate as: the percentage of the System Input Volume (i) which could not be

charged for (calculated by subtracting the Revenue Water Volume[7] (ii) from the System Input Volume (i)). This Non-Revenue Water Rate is hereinafter referred to as the NRW. Therefore, in the IWA's definition, the Non-Revenue Water Volume includes water consumption for public purposes[8] such as water used at public facilities and water used for the maintenance of water supply facilities.

<table>
<tr><th></th><th>Category</th><th>IWA's definition (NRW)</th><th>SABESP's definition (IPF)</th></tr>
<tr><td rowspan="4">System Input Volume</td><td>Billed Authorized Consumption</td><td>Revenue Water Volume</td><td>Revenue Water Volume*</td></tr>
<tr><td>Unbilled Authorized Consumption (water consumption for public purposes)</td><td rowspan="3">Non-Revenue Water Volume</td><td>Water consumption for public purposes **</td></tr>
<tr><td>Apparent Losses</td><td rowspan="2">Non-Revenue Water Volume</td></tr>
<tr><td>Real Losses (leakage)</td></tr>
</table>

Source: Created by the Evaluators through interviews with SABESP.
Note: * The Billed Authorized Consumption and the actual consumption do not match. The actual consumption is lower than the Billed Authorized Consumption.
** The water consumption for public purposes includes the water supplied to Slums (explained below) in addition to water used at public facilities and water used to maintain water supply facilities.

Figure 1: Different Definitions of the Non-Revenue Water Volume

As indicators for non-revenue water control, SABESP uses two Non-Revenue Water Rates that are different from the IWA definition. The first Non-Revenue Water Rate used by SABESP (hereinafter the "IPF") is calculated as follows. Firstly, the following three volumes are subtracted from the System Input Volume (i): the actual water consumption by each household shown on the water meter (iii) for months where the water consumption of the household exceeded 10 $m^3$/month; 10 $m^3$/month for each household (iii) for months where the water consumption of the household did not exceed 10 $m^3$/month[9]; and water consumption for public purposes (iv). The percentage of the resulting volume out of the total System Input Volume (i) is then calculated. Therefore, the IPF is the same as IWA's Non-Revenue Water Rate (NRW) because it is calculated based on the volume of water charged for, but the IPF is different from the NRW in the following two ways: the volume of water charged for and the actual water consumption is different for months where the consumption did not exceed 10 $m^3$; and it does not include water consumption for public purposes. The second Non-Revenue Water Rate used by SABESP (hereinafter the "IPM") is calculated as follows. Firstly, the following two volumes are

[7] The volume of water subject to the collection of water charges.
[8] Water consumption for public purposes includes water used to maintain water purification plants, water used at public facilities and water used by the fire department, etc. for firefighting. While the IWA includes it in the Non-Revenue Water Volume, it is not included in Brazil.
[9] In Brazil, each household is charged a fixed amount when water consumption does not exceed 10 $m^3$/month. The fixed amount is 16.82 reals as of December 2013, which is about 748 yen with the exchange rate of 1 real to 44.47 yen.

subtracted from the System Input Volume (i): the actual water consumption by each household shown on the water meter (iii); and water consumption for public purposes (iv). The percentage of the resulting volume out of the total System Input Volume (i) is then calculated. The IPM is different from the NRW in the following two ways: it is based on actual water consumption rather than the volume of water charged for; and it does not include water consumption for public purposes.

Another important thing to note is the water supplied to Slums. The water supplied to Slums[10] is normally included in the water consumption for public purposes (iv) and therefore it is not included in the Non-Revenue Water Rates used by SABESP (the IPF and the IPM)[11]. Therefore, one should avoid drawing conclusions from simply looking at these numbers because the Non-Revenue Water Rates used by SABESP are different from one used by the IWA. The IPM was used as an indicator for the Project for Capacity Development on Non-Revenue Water Control (subject to this External Evaluation) and the IPF was used as an indicator for SABESP's integrated non-revenue water reduction program (hereinafter the "*Programa*") and the Non Revenue Water Control Project in Sao Paulo State (a yen-loan project). In this evaluation report, the IPF and the IPM will be specified where necessary to avoid confusion.

### 1.3 Outline of the Terminal Evaluation

The project was rated high in general as it was found to have contributed to improving the abilities of counterparts from SABESP which are needed to reduce non-revenue water, through visits to the pilot areas and interviews with relevant personnel.

#### 1.3.1 Achievement of Project Objective at the time of the Terminal Evaluation

The achievement levels for the indicators were as shown below, and the Project Objective was expected to be achieved.

| Indicator | The achievement level at the time of the Terminal Evaluation |
|---|---|
| All 15 Business Units in charge of the distribution of water will launch the non-revenue water reduction plans using technologies obtained through the project. | Based on the non-revenue water reduction plans compiled by the 15 Business Units, SABESP formulated the 11-year Corporate Water Loss Reduction and Energy Efficiency Program[12] in 2009 and was implementing the program. |
| The Non-Revenue Water Rate (IPM) will be reduced to 30% or less at each pilot area by 2010. | Although the target IPM of 30% had not been achieved at the pilot areas, the target IPM was expected to be achieved by the end of the project as a result of technology transfer. |

#### 1.3.2 Achievement of Overall Goal at the time of the Terminal Evaluation

It was likely that the Overall Goal "The Non-Revenue Water Rate (IPM) will be reduced to 30% or

[10] It is estimated that about 11% of the total population of the Sao Paulo Metropolitan area live in Slums (2011). http://exame.abril.com.br/brasil/noticias/sao-paulo-e-metropole-com-mais-moradores-de-favelas-do-brasil-segundo-o-ibge

[11] The IWA includes stolen water in Apparent Losses (i.e. they consider it as part of lost water), but in Brazil, the water supplied to Slums is normally included in the water consumption for public purposes.

[12] SABESP created a draft in 2007. It then completed the final version as the integrated non-revenue water reduction program (the "Programa") in September 2010.

less in SABESP's water supply service area" would be achieved, through the transfer of non-revenue water control technologies and methods to the counterparts via the project, in combination with the implementation of the non-revenue water control plans for all Business Units. Therefore, it was determined that the stable supply of water was likely to be achieved. It was also expected that the project output would be disseminated to other Latin American countries after the project is completed, through international seminars on non-revenue water control[13].

1.3.3 Recommendations at the time of the Terminal Evaluation

The following shows the recommendations at the time of the Terminal Evaluation and the action taken in response to the recommendations at the time of the Ex-Post Evaluation.

| Recommendation at the time of the Terminal Evaluation | Action taken (at the time of the Ex-Post Evaluation) |
|---|---|
| For the remaining four months before the completion of the project, sufficient budget and personnel should be allocated to the activities for non-revenue water control measures specified in the Project Design Matrix (PDM), and the Project Objective's indicator target (the Non-Revenue Water Rate of 30% or less) and the Output 3's indicator target (reducing the rate of leakage by 75%) should be achieved. | As a preventive measure for non-revenue water control, the replacement of water mains and service pipes was conducted at two out of three pilot areas. The effects of preventive measures on reducing the Non-Revenue Water Rate and the rate of leakage would not show up immediately after the measures have been taken. The numerical targets on the Non-Revenue Water Rate and the rate of leakage could not be achieved except for the Non-Revenue Water Rate at one site. |
| To implement non-revenue water control measures effectively, the construction management abilities of private businesses and SABESP's staff members need to be improved. | At the time of the Ex-Post Evaluation, there was a plan that the Brazilian Association of Sanitary and Environmental Engineering (hereinafter the "ABES") would give training to private businesses. |
| The replacement of water mains and service pipes contributes to the reduction of leakage and the detection of illegal connections to the pipes. Therefore, it is desirable to take measures such as the establishment of training and qualification systems for construction supervisors and plumbers and the introduction of the criterion that private businesses must employ a specific number of qualified personnel before being able to place a bid. | After the project ended, the said training course was established at the ABES through SABESP's independent efforts. It is expected that the ABES will provide training to private businesses and a system will be established to outsource piping operations to private businesses which have qualified workers. |
| One cannot ignore Slums when controlling non-revenue water. Although it is an extremely difficult problem to tackle, it is necessary to obtain the accurate volume of water supplied to Slums by installing flow meters at the points where water flows into Slums. | It was difficult for the project to work on non-revenue water control in Slums and the project took virtually no relevant measures. A yen-loan project for non-revenue water control is attempting to understand the volume of water supplied to Slums by installing flow meters at the points where water flows into Slums. |

## 2. Outline of the Evaluation Study

### 2.1 External Evaluators

Yuko Kishino, IC Net Limited

Noriaki Suzuki, IC Net Limited

[13] International seminars on non-revenue water control were held in December 2008 and December 2009, with the participation of Brazil and other Latin American countries.

### 2.2 Duration of Evaluation Study

Duration of the Study: September 2013 - January 2015

Duration of the Field Study: November 25, 2013 - December 5, 2013;

February 13, 2014 - February 23, 2014; and May 12, 2014 - May 16, 2014

## 3. Results of the Evaluation (Overall Rating: B[14])

### 3.1 Relevance (Rating: ③[15])

3.1.1 Relevance to the Development Plan of Brazil

The Pluriannual Plan (PPA) 2004–2007, which was the Brazilian government's national development plan being implemented at the time of the launch of the project, stated that the effective utilization of limited resources is essential for sustainable development and included an efficient water supply in its priority policies. The PPAs 2008–2011 of the Brazilian government and the State of Sao Paulo, which were implemented at the time of the completion of the project, stipulated that they would promote appropriate water management which is important for water resource conservation and the improvement of public health. Therefore, it was confirmed that the PPAs 2008–2011 continued the policies stipulated in the PPA 2004–2007. These policies are in line with the objective of the project, which is the efficient utilization of water. Therefore, the project's relevance to the development policies of Brazil is high.

After creating the first draft of the Corporate Water Loss Reduction and Energy Efficiency Program in December 2007, SABESP set an IPF reduction target for each Business Unit in March 2008. This SABESP policy was in line with the national and state policy as well as the objective of the project, which were to aim at the efficient utilization of water. The *Programa*, which was formulated in September 2010 just after the completion of the project, included activities to promote non-revenue water control including the technologies transferred through the project[16]. The *Programa* is one of SABESP's most important policies for sustaining and strengthening the output of the project.

3.1.2 Relevance to the Development Needs of Brazil

As shown in Table 1, the volume of water supplied per capita per day in the State of Sao Paulo in 2007 and 2010 are 175 liters (L) and 185 L, respectively, which are larger than the national average of 150 L and 159 L, respectively. Therefore, non-revenue water control is the largest issue for SABESP, due to the State of Sao Paulo having the largest demand for water in Brazil, the scarcity of water resources and the water shortages of recent years which have added to the seriousness of the problem[17].

---

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

[15] ③: High; ② Fair; ① Low

[16] To implement the activities, a request for a yen loan was submitted. The loan was approved in 2012 and the yen-loan project started in 2013.

[17] In an average year, the monthly precipitation is 200–300 mm from December to February. However, the precipitation in 2013 and 2014 was much lower than in average years (62 mm in December 2013, 87.7 mm in January 2014 and 22.7 mm in February 2014). At the Cantareira reservoir, which provides water to half of the water supply area in Greater Sao Paulo, the water fell below 18% of capacity as of February 2014, which is less than one third of the water available in

Table 1: Volume of Water Supplied per Capita per Day in Major States (Unit: liters)

| State | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| Bahia | 122.1 | 121.7 | 120.0 | 120.3 |
| Rio de Janeiro | 205.8 | 236.3 | 189.1 | 236.3 |
| Minas Gerais | 142.5 | 138.3 | 137.4 | 147.0 |
| Sao Paulo | 175.0 | 176.0 | 177.8 | 184.7 |
| Parana | 127.0 | 127.5 | 128.7 | 136.5 |
| Brazil's national average | 149.6 | 151.2 | 148.5 | 159.0 |

Source: Calculated from the data of the SNIS (the National Information System on Sanitation).
Note: The volume of water supplied per capita per day is calculated by dividing the water supplied per day by the population in the water supply area.

Both at the time of the launch of the project and at the time of the completion of the project, there was a pressing need to increase water use efficiency and there was a strong need for non-revenue water control. The population living in SABESP's water supply area in the State of Sao Paulo is about 24.11 million (2010)[18] which accounts for about 15% of the total population of Brazil, and therefore the implementation of a project which helped SABESP to control non-revenue water greatly benefited Brazil. Therefore, the project's relevance is extremely high.

3.1.3 Relevance to Japan's ODA Policy

Japan's country-specific ODA policy for Brazil (2006) included the environment in the six priority fields. JICA's country-specific project implementation plan (2007) stipulated assistance for solving urban problems and environmental problems such as waste treatment and air pollution, as part of the assistance for environmental conservation measures. The project was a technical cooperation project with SABESP which is in charge of water supply and sewerage projects in the State of Sao Paulo, and it was in line with Japan's ODA policy at the time of the launch of the project. The response to urban problems remained one of the priority fields in Japan's ODA policy for Brazil at the time of the completion of the project.

3.1.4 Appropriateness of the Plan and Approach

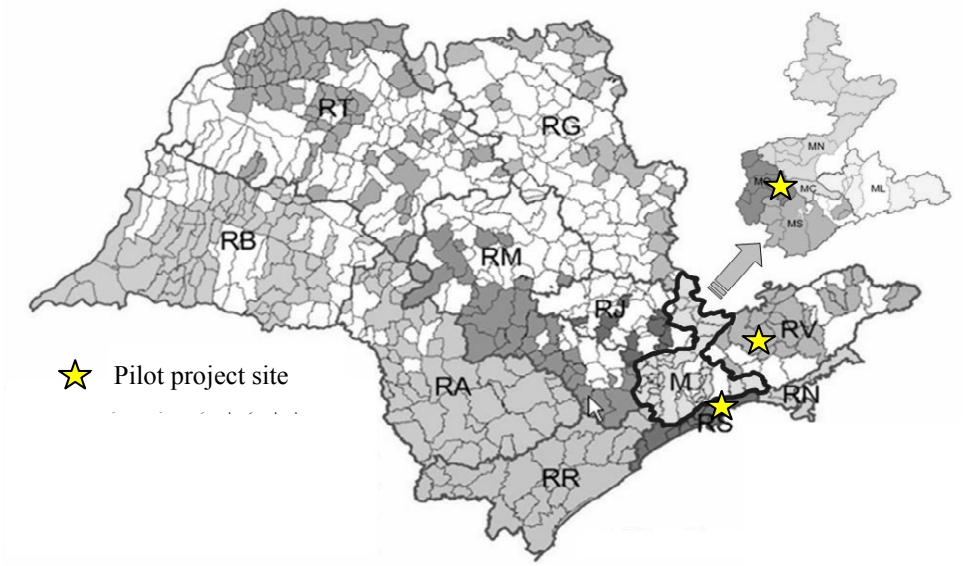
The project took two main approaches: the development of a training program for SABESP staff capacity building and the development of a training system; the planning and the implementation of non-revenue water control at the pilot areas. The project aimed to reduce the Non-Revenue Water Rate at the pilot areas using technologies transferred by Japanese experts as well as improving company-wide abilities to control non-revenue water by launching the non-revenue water reduction plans in all 15 Business Unit areas covered by SABESP. In the long term, the project also aimed to create systems to develop the human resources needed for non-revenue water control. In short, the focus of the above-mentioned approaches was to successfully disseminate the practices used at the pilot areas to other SABESP personnel and to establish a successful dissemination system. Although

average years.
[18] Calculated using SNIS (the National Information System on Sanitation) data. This is 1.88 times the population covered by the Bureau of Waterworks, Tokyo Metropolitan Government (12.84 million, as of April 2010).

there was no problem in the selection of pilot areas or the activities at the pilot areas, there was some room for improvement in the approaches taken and the indicators set in the $PDM_1$ which was created as a result of a revision made after a mid-term review of 2008, as explained below.

(1) The Selection of Pilot areas

Out of the 15 Business Unit areas, the following three areas were selected: the Metropolitan Region West Business Unit area (hereinafter "MO"); the Regional Baixada Santista Business Unit area (hereinafter "RS"); and the Regional Vale do Paraíba Business Unit area (hereinafter "RV"). One pilot area was then selected from each of the three selected Business Unit areas. Table 2 shows the names of the pilot areas.




Source: Project Completion Report for the Non-revenue Water Control project

Figure 2: SABESP Business Unit and Pilot areas

Table 2: The Average IPM at Each Pilot Area in 2007

| Pilot area name | IPM (%) | IPM in the relevant Business Unit area (%) |
|---|---|---|
| Jaguaré | 36.9*1 | MO: 34.8 |
| Vila Baiana | 51.7*1 | RS: 42.5 |
| Jardim das Colinas | 68.2*2 | RV: 41.0 |

Source: Calculated using non-revenue water control information system data owned by SABESP.
*1: The IPM for the whole sector which includes the relevant site is shown, as data on the IPM for each site is not available.
*2: The IPM for the relevant site is shown, as the relevant site is the whole sector.

As shown above, the average IPM at each pilot area in 2007 is higher than the average IPM in the water supply service area of the relevant Business Unit, i.e., priority sites which require non-revenue water control more than other sites were selected as pilot project sites. MO, where one of the pilot areas is located, is a metropolitan area where mainly middle class people reside. It has a high rate of leakage and there is a strong need for the replacement of water service pipes, because the area was developed many years ago. This means that the area requires both the corrective measures and the preventive measures which are included in the project's non-revenue water control measures. RS contains Slums and tourist sites. In this area, non-revenue water includes various components, and the consumption of water fluctuates depending on the season and the time of the day. Therefore, for this area, the project's fundamental measures for non-revenue water control as well as water pressure adjustment as a preventive measure are important. RV is a detached condominium where wealthy people reside. There is a strong need for the replacement of water mains because the construction of the mains was not appropriate when the developer constructed the water supply and sewage systems in the 1970s.

It was appropriate for the project to select pilot areas from the three areas which have different characteristics and have a strong need for non-revenue water control, in order to achieve the Overall Goal of disseminating the non-revenue water control methods proposed by the project to the rest of the SABESP water supply area.

(2) Project Approaches

Four "Outputs" set by the project laid out the means for achieving the Project Purpose "SABESP will increase its non-revenue water control abilities." However, only Output 1 was relevant to the whole of SABESP because Output 2, Output 3 and Output 4 laid out the means for strengthening non-revenue water control for the pilot areas. The counterparts subject to technology transfer at pilot areas accounted for less than 2% of the engineers and operational and maintenance personnel working at all the Business Units. There was no plan to conduct activities to train leaders at the Business Units where no pilot projects were conducted. The connection was weak between the achievement of the Outputs and the achievement of the Project Purpose because there were only a few activities to disseminate the results of the activities at the pilot areas to the whole company.

(3) Indicators

As shown below, the indicators set in the $PDM_1$ seemed to have room for improvement.

- ✓ One of the indicators for the Project Purpose was, "The NRW control plans are carried out in all the 15 business units." This could have been used as an indicator for assessing the capacity development levels achieved by SABESP through the dissemination activities and training.
- ✓ Indicators for Output 1 included, "10 training courses (curricula) are created and carried out." and "The 10 training courses target all the 15 business units, and both managerial and technical staff of SABESP participate in the training courses." These indicators only state the progress of the activities. Therefore, it was necessary to set indicators which assess the extent to which the project was able to strengthen the training implementation systems for the other Business Units and develop the abilities of the staff members at the other Business Units.
- ✓ As an indicator for Output 2, a numerical target could have been set to assess the extent to which the engineers at the pilot areas deepened their understanding of non-revenue water.
- ✓ The indicator for Output 3 was, "The water leakage rate is reduced by 75% in the pilot areas, compared with the rate measured at the beginning of the activities in the pilot areas." This could have been used as an indicator for assessing the achievement level for the technology transfer regarding corrective measures.

As explained above, the path set in the plan for achieving the project purpose was insufficient and there was some room for improvement in setting indicators. However, in light of the policy objectives of the efficient utilization of water resources and the streamlining of water supply, the project purpose was appropriate. In addition, the project has been highly relevant to the country's development plan, development needs, as well as Japan's ODA policy. Therefore, the project's relevance is high.

### 3.2 Effectiveness and Impact[19] (Rating: ②)

3.2.1 Effectiveness

The Ex-Post Evaluation Study confirmed that there were differences between the achievement levels for the different Outputs and the Project Purpose, at the completion of the project. The main reasons why some Outputs could not be achieved were the lack of budget and personnel for the replacement of water service pipes and mains[20]. The following explains the achievement levels at the completion of the project and the achievement levels when the Ex-Post Evaluation was carried out, based on the $PDM_1$.

3.2.1.1 Project Output

1) **Output 1** "The SABESP staff who are involved in the Project understand the significance of NRW control, and the system for the human resources development is strengthened.": Partially achieved.

[19] The rating must be determined by taking into account the assessment results for both the Effectiveness and the Impact.
[20] These factors were mentioned in the $PDM_1$ as "external factors."

Although training courses for non-revenue water control measures were sufficient qualitatively and quantitatively, the project could not implement training sufficiently for all the Business Units before the project was completed. At the time of the Ex-Post Evaluation, it was confirmed that non-revenue water control measures started to be disseminated to the other Business Units, thanks to the efforts of SABESP.

**Indicator (1)** "10 training courses (curricula) are created and carried out":

Fully achieved. The project developed a training program where 13 courses were created under four themes. After the project ended, SABESP made alterations to the teaching materials for the "Introduction of Model for Water Distribution Network Analysis" which is part of the training program. In 2013, the ABES took over these courses and added them to its training programs. From 2014 onwards, the ABES will conduct training for strengthening non-revenue water control. The training courses developed by the project were determined to be sufficient both qualitatively and quantitatively.

**Indicator (2)** "The 10 training courses target all the 15 business units, and both managerial and technical staff of SABESP participate in the training courses":

Not achieved. The 13 training courses were held once. Although participants included staff from all Business Units, all of them were administrators and there were no technical staff. It was expected that the participants would become training instructors after taking the training courses and disseminate the technologies by giving training at their Business Units. However, training of trainers (TOT) was not included in the Plan of Operations during the project period, and at the time of the Ex-Post Evaluation, we could not confirm that the participants held TOT.

**Indicator (3)** "Engineers and workers of private construction firms participate in the training course(s)":

Not achieved. There were no participants from private businesses. However, as mentioned above, it was decided that the teaching materials for the training developed by the project would be used as official teaching materials for the training provided by the ABES after they had been revised by SABESP. This made it possible for private businesses to apply for the training and receive the training from the ABES rather than receiving the training from SABESP. Those who have completed the training are given a certificate of completion. If they pass the examination conducted by the Brazilian Association for Non-Destructive Inspection which is a national technical accreditation agency, they will be given a qualification for technologies concerning non-revenue water. This qualification will become one of the criteria that private businesses must meet when placing a bid for construction work related to non-revenue water control in the SABESP water supply area. There is no doubt that the results of the project's activities will be utilized to train private sector engineers who will be engaged in non-revenue water control.

2) **Output 2** "Fundamental measures for NRW control are strengthened through practice in the pilot areas": Fully achieved.

**Indicator (1)** "The technical staff of the pilot areas will be able to identify the components of NRW and the rate of each component."

Fully achieved. Electromagnetic Type Flow Meters were installed and the measurement of the System Input Volume was launched at all the pilot areas before the project ended. They identified the components of non-revenue water through a series of activities including measuring the volume of leakage and identifying sources of the stolen water. In RS, they succeeded in measuring the volume of water used in Slums using Ultrasonic Type Flow Meters. From the results of interviews and beneficiary surveys in the Ex-Post Evaluation Study, it was confirmed that the identification of factors causing non-revenue water[21] (which is the most important fundamental measure) was fully implemented at the pilot areas, and that many technology transfer activities are taking place within each Business Unit area. In particular, in MO, they conducted zoning for the service area and installed automatic water flow and pressure sensors in each zone, which constantly check and adjust the volume of water and the water pressure automatically.

**Indicator (2)** "The technical staff of the pilot areas will be able to utilize GIS (information about maps, pipes, leakage, customers, etc.) in NRW control."[22]:

Partially achieved. A Japanese expert recommended that they should build a system which enables the centralized management of all the data on fundamental measures related to non-revenue water control using SABESP's databank, before the project ends. At the time of the completion of the project, the data collected through direct measurement was being accumulated and the quality of the data was improving. At the time of the Ex-Post Evaluation, administrators at each Business Unit were developing and managing GIS data[23]. The databank contains various types of data along with map information, including the locations where leakages were detected, piping diagrams, the progress in the replacement of water mains and service pipes, the service pipe diagram for each household, and the service provided to each household. The system enables the extraction and management of data on non-revenue water control from the databank.

3) **Output 3** "Corrective measures for NRW control are strengthened through practice in the pilot areas": Partially achieved.

Although the numerical target set at the time of the mid-term evaluation could not be achieved, corrective measures for non-revenue water control were taken including the detection and repair of

[21] They include identifying non-revenue water components through the inspection of the volume of leakages, the measurement of the lowest flow during the night, leakage repair and the replacement of water service pipes.

[22] This means that "The engineers will be trained to be able to utilize existing databases including GIS for non-revenue water control measures." Source: Materials provided by JICA.

[23] The progress in the development and management of GIS data varied depending on the Business Unit. GIS data for MO was already in use and GIS data for RS and RV were still being developed.

leakages.

**Indicator (1)** "The water leakage rate is reduced by 75% in the pilot areas, compared with the rate measured at the beginning of the activities in the pilot areas":

Not achieved. As shown in Table 3, the rate of leakage at the pilot areas was reduced by 63% in MO, 52% in RV and 10% in RS by the time of the completion of the project, when compared to the levels at the time of the launch of the project. Therefore, the target of a 75% reduction was not achieved. However, an interview with SABESP found that the rate of leakage as of May 2010 was 28% in RS and 30% in RV, which are the same or lower than the guideline level set by SABESP (30%). Therefore, the project was effective to a certain extent. Because the rate of leakage at the pilot areas was reduced to the guideline level, SABESP decided to prioritize areas which have a higher rate of leakage for the implementation of corrective measures. When considering SABESP's policy, it was not appropriate to set the target of reducing the rate of leakage by 75%[24] for all the pilot areas, although some Business Units already had a rate of leakage close to the guideline level of 30% around the time of the launch of the project (e.g. 31% in RS[25]).

Table 3: The Rate of Leakage at the Pilot Areas

| | MO (%) | RS (%) | RV (%) |
|---|---|---|---|
| The baseline rate of leakage (2007) (%): a | 59 | 31 | 62 |
| The target rate of leakage (%): a/4 = b | 15 | 8 | 16 |
| The rate of leakage in May 2010 (%): c | 22 | 28 | 30 |
| The reduction rate (a-c)/c | 63% | 10% | 52% |

Source: Materials provided by JICA.
Note: After the project ended, they stopped using the method for checking the rate of leakage that was used at the time of the project.

In the Ex-Post Evaluation Study, it was confirmed that corrective measures (such as the detection of leakages from water mains, the water-tightness inspection for water service pipes and the repair of water mains and service pipes) were being conducted in many other parts of MO, RS and RV, using the knowledge and experience obtained through the project.

4) **Output 4** "Preventive measures for NRW control are strengthened through practice in the pilot areas": Partially achieved.

Although the implementation of preventive measures lagged behind because of SABESP's budget shortages, targets for the replacement of water service pipes and mains were mostly achieved. The detection of leakages and the adjustment of water pressures to appropriate levels have been adopted in many areas as very inexpensive and effective measures. However, the target for patrols could not be achieved because of personnel shortages at SABESP.

[24] The reason for setting the target of reducing the rate of leakage by 75% was not explained in any materials, nor could it be given in interviews with relevant personnel.
[25] The pilot area in RS had a much lower baseline rate of leakage than the other sites because it is a tourist site except for the Slums and the water mains and service pipes were relatively new.

**Indicator (1)** "Aged and deteriorated pipes are replaced in the pilot areas":

Mostly achieved (the replacement of water service pipes: 1,387 out of 1,467 places, 95% achieved; the replacement of water mains: 7,821 out of 7,821 meters, 100% achieved). In RV, the replacement of water service pipes and mains was conducted as planned. In MO, all the service pipes and mains which required replacement in 2008 and 2009 were replaced. The replacement of service pipes for 200 places was planned for 2010, but SABESP determined after the Terminal Evaluation that replacements for 73 places should be sufficient, and the replacements for all 73 places was completed. In RS, the replacement of water service pipes was planned for 80 places and the plan was to complete the replacement for all 80 places before the end of the project, but the plan was not implemented. This was because the RS Business Unit decided not to implement the plan during the project period, as the replacement of water service pipes had been planned for in the Non Revenue Water Control Project in Sao Paulo State.

Table 4: Preventive Measures for Non-Revenue Water Control Taken in the Pilot Areas

| Pilot area | | Water service pipes replaced (unit: places) | | Water mains replaced (unit: meters) | |
|---|---|---|---|---|---|
| | | At the Terminal Evaluation | At the Ex-Post Evaluation | At the Terminal Evaluation | At the Ex-Post Evaluation |
| MO | 2008 | 36 | 36 (100% achieved) | No plan | No plan |
| | 2009 | 492 | 493 (100% achieved) | No plan | No plan |
| | 2010 | 200 (initial plan) | 73 (100% achieved) | No plan | No plan |
| RV | 2007 | 349 | 349 (100% achieved) | 7,821 | 7,821 |
| | 2010 | 445 (initial plan) | 436 (100% achieved) | No plan | No plan |
| RS | 2010 | 80 | 0 (0% achieved) | No plan | No plan |

Source: Created by the Evaluators based on the results of interviews with SABESP at the time of the Ex-Post Evaluation.

**Indicator (2)** "Water pressure is adjusted to the appropriate level in the pilot areas":

Partially achieved. The water pressure adjustment was conducted in RS and RV before the project ended, but it was not conducted in MO. This is because the need for the water pressure adjustment proposed by the project diminished as the remote automatic adjustment of the water volume and pressure was enabled[26] in MO after the project ended. In RV and RS where the installation of automatic detection and adjustment equipment has not progressed, the low-cost and sustainable water adjustment method proposed by the project is useful, and it was still being used at the time of the Ex-Post Evaluation. Water pressure adjustment is a proven technology in Japan. The technology was transferred not only to administrators but also to engineers who work on the ground, and administrators participated in OJT. These activities facilitated communication between administrators and engineers, which contributed to reducing the differences in awareness about the problems faced on

[26] The automatic adjustment using the measurement management zones (DMC), micro gauges and the General Packet Radio Service (GPRS).

the ground. The establishment of the technology within SABESP was enabled by the fact that SABESP had the human resources, financial strength and organization needed to utilize the technology continuously.

**Indicator (3)** "Patrol on the pipelines is conducted on the regular basis in the pilot areas in accordance with a manual on preventive measures":

Not achieved. Patrol activities were hardly conducted because of personnel shortages. However, the method proposed by the project (taking photographs of the progress in construction work and improving work efficiency) was being used at the time of the Ex-Post Evaluation, and was contributing to strengthening preventive measures.

3.2.1.2 Achievement of Project Purpose

**Indicator 1** "The NRW control plans are carried out in all the 15 business units":

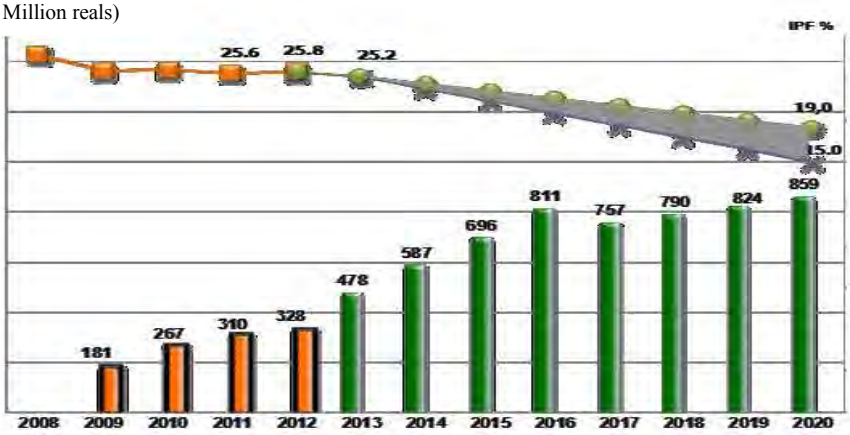
Not achieved. At the time of the mid-term review, it was confirmed that non-revenue water reduction plans had already been formulated by all 15 Business Units, and it was proposed that the plans should be launched by each Business Unit before the end of the project. The completion report stated that the Corporate Water Loss Reduction and Energy Efficiency Program was formulated and being implemented during the project period. However, in reality, the Corporate Water Loss Reduction and Energy Efficiency Program had only set the reduction target for the Non-Revenue Water Rate by the time the project had been completed. It was only in March 2010, four months before the completion of the project, that they started the actual formulation of the non-revenue water reduction plans. In September 2010, after the project ended, the plan for the Integrated Non-Revenue Water Reduction Program *(the Programa,* Table 5) was completed and launched.

Table 5: An Outline of the Integrated Non-Revenue Water Reduction Program (the *Programa*)

| Program period | 2009–2019 |
|---|---|
| Objective | The long-term reduction in the Non-Revenue Water Rate (IPF) will be achieved. |
| Expected outcome | - The plans for non-revenue water reduction will be integrated into one plan.<br>- Financial support for achieving the long-term reduction of the Non-Revenue Water Rate will be strengthened. |
| Main activities | - The replacement of water service pipes and mains<br>- Zoning and the improvement of the water supply service area<br>- The water-tightness surveys for service pipes within household properties and the detection of leakages<br>- The installation of water pressure regulators and automatic water flow and water pressure measuring instruments<br>- The control of illegal water supply (except for Slums)<br>- The replacement of water meters |

Source: SABESP

(Unit: Million reals)




| | |
|---|---|
| | Planned budget to reduce the non-revenue water rate |
| | Executed budget to reduce the non-revenue water rate |
| | Achieved non-revenue water rate (SABESP water supply area) |
| | Minimum target non-revenue water rate |
| | Maximum target non-revenue water rate |

Source: JICA presentation document for the Programa Investment Plans, elaborated by the SABESP (Dec. 2013)

Figure 3: *Programa* Investment Plans and Targets (IPF)

**Indicator 2** "The NRW rate in each pilot area is reduced to less than 30%":

Changes in the IPM at each pilot area are shown in Table 6.

Table 6: Changes in the IPM at Each Pilot Area (Unit: %)

| Pilot area name | 2007 (7-12) | 2008 (1-6) | 2008 (7-12) | 2009 (1-6) | 2009 (7-12) | 2010 (1-5) |
|---|---|---|---|---|---|---|
| Jaguaré (MO) | **46.3** | **44.6** | Not calculated | 42.6 | 39.0 | 30.9 |
| Vila Baiana (RS) | 58.5 | 62.6 | 60.2 | 51.2 | 44.2 | 27.9 |
| Jardim das Colinas (RV) | 61.2 | 36.1 | 32.3 | 35.4 | 40.5 | 37.4 |

Source: The figures shown in bold were obtained from the mid-term review report. The other figures were calculated by the Evaluators based on the monthly Non-Revenue Water Volume table included in the completion report.
Note: The above table shows the IPM which is used in the project purpose.

In RS, the IPM was reduced from 58.5% in the year when the project started to 27.9% in the 2010 January-May term. This was because the analysis of the System Input Volume progressed and water consumption was measured accurately through the implementation of the project, which enabled specific non-revenue water control measures[27]. In MO and RV, considerable effects were observed: the IPM was reduced from 46.3% and 61.2% in the 2007 July-December term to 30.9% and 37.4%, respectively. The IPM in RV was further reduced and the average IPM in the 2010 July-December term fell to 34.4%[28]. However, the IPM did not fall below 30% because of issues including the delay in the replacement of water service pipes and mains.

[27] The first measure is to improve the accuracy of the System Input Volume analysis by measuring the water flow into Slums and identifying water taps that are not in use. The second measure is to reduce the water pressure from 30 kPa to 20 kPa which does not affect water supply and to adjust the water pressure during the night where necessary, in order to reduce leakages.

[28] The IPM (c) for June and July 2010 was not calculated for the pilot areas in MO and RS. Data was not available because the IPM was not monitored at the pilot areas after the project ended.

As explained above, some parts of the indicators have not achieved the intended results in the project purpose objectives. However, the Non-Revenue Water Rates in the pilot areas have improved substantially, and for the whole the SABESP, the project counterparts have been playing its central role toward the non-revenue water reduction. Therefore, it can be judged that the project has had a certain degree of positive outcomes.

3.2.1.3 External Factors Which Contributed to or Interfered with the Project's Effectiveness

During the project period, SABESP employed a local consultant and implemented the Methods of Analysis and Solution for Water Losses and Non-Revenue Water Problems (MASPP). This program aimed to hold workshops which are designed to make all the SABESP staff members recognize their roles once again and raise their awareness. The program consequently created the conditions needed for the dissemination of non-revenue water control technologies resulting from the project to other Business Units.

Regarding the preventive measures for non-revenue water control stipulated in Output 4, the following factors interfered with the project's progress, among others: the budget allocated by SABESP for the replacement of water service pipes and mains was insufficient; the procedures for contracting construction work were delayed; and the construction abilities of outsourced companies were insufficient. As a result, the launch of construction in RV was postponed to February 2010 which was five months before the completion of the project. They contributed to the failure to achieve a portion of the Project Purpose as a consequence.

3.2.2 Impact

3.2.2.1 Achievement of Overall Goal

**Indicator** "The NRW rate in the SABESP's service area will be reduced to less than 30% by the year 2015":

Changes in the IPM in SABESP's water supply service area are shown in Table 7.

Table 7: Changes in the IPM

| The Non-Revenue Water Rate (IPM) (%): c | | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| Results | The whole of SABESP | 35.8 | 34.1 | 32.4 | 32.3 | 32.0 | 32.1 | 31.2 |
| | The Sao Paulo Metropolitan Region Executive Office | 34.6 | 32.7 | 31.4 | 31.9 | 31.3 | 31.8 | 30.8 |
| | The Regional Systems Executive Office | 39.1 | 37.9 | 35.3 | 33.3 | 33.9 | 32.9 | 32.3 |

Source: The information was provided by the administrative division for the integrated non-revenue water reduction program at SABESP's Technology, Enterprises and Environment Executive Office.
Note: The above table was created with the premise that the Non-Revenue Water Rate stated in the reduction target set as the project's Overall Goal refers to an IPM.

The IPM for the whole of SABESP was observed between 30% and 33% at the time of the Ex-Post

Evaluation (2013). In 2013, the Non Revenue Water Control Project in Sao Paulo State was launched based on the *Programa*, and the Non-Revenue Water Rate which had stopped dropping was reduced by 0.9% from the previous year's level. It is likely that the Overall Goal will be achieved by 2015 which is the target year for the Overall Goal, through the implementation of the Non Revenue Water Control Project in Sao Paulo State.

3.2.2.2 Contribution of Project to Overall Goal

A beneficiary survey[29] was conducted to confirm the degree to which the project has contributed to the Overall Goal. Three points were confirmed: (1) To what extent has the transferred non-revenue water control technology been understood? (2) Thirteen training courses on non-revenue water control were developed as part of the project. To what extent have these training courses been utilized? (3) How much awareness is there for the importance of reducing the Non-Revenue Water Rate?

(1) Grasp of non-revenue water control technology

Personnel at the Business Units in the pilot areas had a good grasp of the transferred technology, and were still utilizing it after the completion of the project. This is also evident from the results of the beneficiary survey shown in Table 8. The decrease in IPM at the Business Units in the pilot areas is largely attributable to the staff to whom the technology was transferred. Despite more than half of the staff members being reassigned after the completion of the project, the technology was transferred from the reassigned staff members to the new ones, who were actively working on measures to reduce non-revenue water.

Table 8: Understanding of Transferred Technology by the Business Units in the Pilot Areas

| Key transferred technology | MO | RS | RV |
|---|---|---|---|
| Division of water service areas, and understanding of the volume of water flowing in each area | In practice throughout entire area<br>By individual DMCs | Partially maintained (25%)<br>Sector by sector | Maintained throughout entire area<br>Sector by sector |
| Appropriate adjustment of water pressure during the day and night | Automatically controlled throughout entire area | Adjusted throughout entire area as circumstances demand | Adjusted throughout entire area as circumstances demand |
| Testing for water-tightness following installation of service pipes | Performed throughout entire area | Performed in 80% of area | Performed throughout entire area |
| Testing for water-tightness prior to laying of service pipes | Performed throughout entire area | Performed in half of area | Performed at all new installations |
| Using photos, understanding the progress for each phase of implementation | Performed throughout entire area for all phases | Performed throughout entire area for all phases | Performed throughout entire area for all phases |
| Total evaluation of the grasp of transferred technology | 100%<br>Has adopted advanced technologies, such as the automatic adjustment of water pressure | 70%<br>Good grasp of the transferred technology | 100%<br>Full use of the transferred technology |

Source: Compiled by the evaluator based on the results of the beneficiary survey of 90 SABESP staff members.

[29] The format for the beneficiary survey was a focus group discussion. At each of the nine business units, ten people were divided into two groups of five.

Ever since the project period, MO has been utilizing advanced technologies, such as the automatic adjustment of water pressure, as well as technologies for digitalizing the implementation progress and sharing it with those concerned. RV has utilized the transferred technology throughout its entire area. Overall, RS utilizes the transferred technology in 70% of its area. Although this is lower than the other pilot areas, all of the RS participants in the beneficiary survey had a grasp of the technology.

On the other hand, Table 9 shows the results of the beneficiary survey for the Business Units outside the pilot areas. As can be seen, the final evaluation of Business Units in metropolitan areas—MC,[30] MN,[31] and MS[32]—was about 70%, whereas, it was about 50% for Business Units in regional areas—RA,[33] RJ[34] and RN.[35] MN was selected by SABESP as a type of pilot area called a "mirror area," and under the guidance of experts from the project, several OJT sessions were held here. This is thought to have had an impact on the particularly high evaluation of MN. MO played a central role in providing guidance on measures to reduce non-revenue water, and this had a positive bearing in MC and MN. This kind of dissemination of technology was inadequate at the Regional Systems Executive Office Business Units, and it is presumed that this is why the results were somewhat low.

Table 9: Understanding of Transferred Technology by the Six Business Units outside the Pilot Areas

| Key transferred technology | MC | MN | MS | RA | RJ | RN |
|---|---|---|---|---|---|---|
| Division of water service areas, and understanding of the volume of water flowing in each area | 50% | 100% | 50% | 50% | 50% | 50% |
| Appropriate adjustment of water pressure during the day and night | 50% | 100% | 100% | 50% | 50% | 50% |
| Testing for water-tightness following installation of service pipes | 100% | 60% | 50% | 50% | 50% | 50% |
| Testing for water-tightness prior to laying of service pipes | 50% | 20% | 50% | 0% | 50% | 50% |
| Using photos, understanding the progress for each phase of implementation | 50% | 75% | 80% | 50% | 60% | 75% |
| Total evaluation of the grasp of transferred technology | 60% | 71% | 66% | 40% | 52% | 55% |

Source: Compiled by the evaluator based on the results of the beneficiary survey of 90 SABESP staff members.

(2) Utilization of the 13 training courses on non-revenue water control

Thirteen training courses on non-revenue water control were developed in the project. As shown in Table 10, at the time of the Ex-Post Evaluation, the rate at which the courses were being utilized was low, with 50% of staff members utilizing the courses at MO, and no more than 30% at other business units. This is because they were at a stage where verification of the training program had only just been completed in 2013. The Technology Development and Maintenance Department of the Planning

[30] Sao Paulo Metropolitan Center Business Unit.
[31] Sao Paulo Metropolitan North Business Unit.
[32] Sao Paulo Metropolitan South Business Unit.
[33] Sao Paulo State Alto Paranapanema Regional Business Unit.
[34] Sao Paulo State Capivari / Jundiaí Regional Business Unit.
[35] Sao Paulo State Litoral Norte Regional Business Unit.

Office (TOE), which is also a recipient of the technology transfer and is in charge of monitoring, played a central role in improving the training courses, and the private-sector enterprises involved in the Non Revenue Water Control Project in Sao Paulo State were obliged to undertake ABES certification training. A decision has been made to carry out full-scale training in 2014. Through this, it is expected that further reductions in IPM will be achieved.

Table 10: Utilization of the 13 Training Courses after Completion of the Project

| | MO | MC | MN | MS | RS | RV | RA | RJ | RN |
|---|---|---|---|---|---|---|---|---|---|
| Number of respondents | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Number of people utilizing courses | 5 | 3 | 3 | 1 | 0 | 1 | 2 | 1 | 0 |
| Rate of utilization | 50% | 30% | 30% | 10% | 0% | 10% | 20% | 10% | 10% |

Source: Compiled by the evaluator based on the results of the beneficiary survey of 90 SABESP staff members.

(3) Recognition of the importance of reducing the Non-Revenue Water Rate

As shown in Table 11, the percentage of those who recognize the importance of reducing the Non-Revenue Water Rate is extremely high, between 80% and 100%. Interviews have also confirmed that TOE took the lead in providing support to business units for activities related to non-revenue water. It appears that a consequence of strengthening technology in the pilot areas was that awareness for reducing non-revenue water spread, with TOE appealing to all business units. On the whole, the degree of recognition was higher in metropolitan areas than in regional areas, and this is as a result of the TOE having had a greater involvement in the geographically closer metropolitan areas.

Table 11: Recognition of the Importance of Reducing the Non-Revenue Water Rate

| | MO | MC | MN | MS | RS | RV | RA | RJ | RN |
|---|---|---|---|---|---|---|---|---|---|
| Number of respondents | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Number of respondents recognizing importance | 10 | 10 | 8 | 10 | 9 | 9 | 9 | 9 | 9 |
| Rate of recognition | 100% | 100% | 80% | 100% | 90% | 90% | 90% | 90% | 90% |

Source: Compiled by the evaluator based on the results of the beneficiary survey of 90 SABESP staff members.

3.2.2.3 Other Impacts

During the project period, an international seminar was held on measures for controlling non-revenue water. This enabled the achievements of the project in the pilot areas to also be disseminated to participants not only from Brazil but also from other Latin American countries. Taking advantage of this opportunity, a third-country training program (TCTP) was planned by taking advantage of a JICA scheme, with an aim of making SABESP the focus of training for measures to reduce non-revenue water in Latin America. Since the completion of the project, a total of three third-country training programs have already been implemented.

A certain degree of positive outcomes was observed in the project, and therefore, the

effectiveness/impact of the project is fair. At Business Units in the pilot areas, the penetration rate of transferred technology was high, the level of accumulated technology was high, and the awareness of staff members was high. In addition, the control of non-revenue water had been put into practice, and as a result, this led to a considerable improvement in the Non-Revenue Water Rate. Even at Business Units outside the pilot areas, it was confirmed that the percentage of those recognizing the importance of reducing the Non-Revenue Water Rate was high, between 80% and 100%, and the total evaluation of the grasp of transferred technology had also advanced to between 40% and 70%. The project produced a change in the activities of the direct counterpart, namely TOE, and resulted in the creation of solid foundations for the control of non-revenue water. For instance, the influence of TOE led to a sufficient budget being allocated. With the start of full-scale training courses developed in the project for non-revenue water control technology, coupled with the effects of the Non Revenue Water Control Project in Sao Paulo State, the Overall Goal is expected to be achieved by 2015.

### 3.3 Efficiency (Rating: ②)

3.3.1 Inputs

The planned inputs and actual inputs are as follows.

| Inputs | Plan | **Actual** (at completion) |
|---|---|---|
| (1) Experts dispatched | ● Long-term: 1 (total: 36 months)<br>● Short-term: 4 (total: 41 months)<br>Total: 77 person-months | ● Long-term: 1 (36 months)<br>● Short-term: 9 (46.5 months)<br>Total: 82.5 person-months |
| (2) Trainees received | ● Number of trainees: about 15 every year<br>● Main fields of training:<br>General measures to reduce non-revenue water<br>Improvement of water supply equipment | ● Total number of trainees: 50<br>● Main fields of training<br>Measures for the comprehensive management of non-revenue water<br>Sharing of expertise in Japan on achieving and maintaining low Non-Revenue Water Rate |
| (3) Third-country training programs | - | - |
| (4) Equipment | ● Provision of equipment: 45 million yen over 3 years<br>● Main input equipment<br>Electromagnetic type flow meters, micro flow sensors for night minimum flow, etc. | ● Provision of equipment: 35.4 million yen<br>● Expenses borne by Japanese side: 24.4 million yen<br>● Main input equipment<br>Portable electromagnetic / ultrasonic type flow meters, sonic pipe locators, correlative water leak detectors, endoscope pipe inspection cameras |
| Total project cost | Total: 290 million yen | Total: 362 million yen |
| Input from the recipient government | ● Assignment of counterparts (total of 49 staff members in 11 departments)<br>● Office space for experts and project staff<br>● Training costs (personnel expenses, transportation expenses, daily allowance/accommodation allowance, instructor remuneration)<br>● Improvement of training centers<br>● Costs involved in project for reducing non-revenue water in pilot areas<br>Total (*no planned value*) | ● Assignment of counterparts (total of 82 staff members in 14 departments)<br>● Office space for experts and project staff<br>● Training costs (personnel expenses, transportation expenses, daily allowance/accommodation allowance, instructor remuneration)<br>● Improvement of training centers<br>● Costs involved in project for reducing non-revenue water in pilot areas<br>Total: 19.2 million yen |

3.3.1.1 Elements of Inputs

Overall, the input from the Japanese side was slightly greater than planned. At the time of planning, short-term experts had been envisaged for the four areas of non-revenue water management and construction supervision, water distribution management, technologies for detecting leaks, and training programs. In addition to these areas, however, experts were also dispatched to the areas of water works and water service planning. The fact that experts for training programs and planning were dispatched for shorter periods of time meant that the inputs for disseminating the outputs from the pilot areas throughout all of SABESP were restricted, and was also a factor in limiting the dissemination of project outputs. As for the inputs from the Brazilian side, although the assignment of counterparts was greater than planned, the inputs apart from the costs in the pilot areas were as planned.

Of the outputs for the pilot areas, Output 4 did not proceed as planned because of a budget shortfall on the part of SABESP. For instance, in MO and RV, the replacement of pipes was delayed, and in RS, service pipes could not be replaced. The provided equipment has continued to be used.

Although the utilization of in-pipe cameras is low, this did not have a significant effect on outputs because the cost of providing the cameras is no more than about 6% of the total.

3.3.1.2 Project Cost

The project cost was 24% higher than planned. Whereas the planned cost was 290 million yen, the actual cost was 362 million yen. The increase was due to an increase in the number of experts dispatched and the number of trainees accepted.

3.3.1.3 Period of Cooperation

The period of cooperation was 100% as planned, namely 36 months.

3.3.2 Project Implementation Structure

Originally, the project established two pilot areas: MO from among metropolitan areas, and RS from among coastal regional areas. Later, RV was added as an inland regional area. In other words, in addition to SABESP headquarters, there were three project sites. RV and RS were more than 400 km apart, and both were more than 250 km away from headquarters. Thus, the project extended across a wide area, and although there were several project offices, a local coordinator was not assigned immediately after the start of the project. This did not pose any particular problems in terms of transferring technology through OJT, but in terms of infrastructure development in the pilot areas, such as the replacement of service pipes and distribution pipes, differences in language resulted in less than perfect communication and operational inefficiencies with the Brazilian government agencies. These resulted in an inordinate amount of time being spent on licensing procedures, and the start of construction being delayed. A local coordinator was assigned six months later, and these problems disappeared. If a local coordinator had been assigned immediately after the start of the project, the preceding activities at MO might have been implemented sooner, the knowledge and experience obtained from these activities might have been gleaned earlier, and the biggest challenge in this project—namely, dissemination to other Business Units—might have been promoted.

RV had been added afterward, and with no coordinator being assigned, the coordinator at RS was dealing with both sites single-handedly. The RS coordinator frequently worked at SABESP headquarters, and so the local sites were seldom inspected. There were delays in assessing the actual conditions and confirming the progress at RV and RS, and eventually, the activities here were more limited than those at MO. It would have been preferable to have an SABESP coordinator assigned to the business units responsible for each of the pilot areas.

In contrast, the transfer of technology through OJT was promoted while sharing with management any on-site issues and lessons learned, and while following the PDCA (Plan-Do-Check-Act) cycle according to circumstances. SABESP had lacked such a technique previously, and the counterparts evaluated it very highly as an effective and efficient practice.

In light of the above, despite the period of cooperation being kept to plan, project costs were higher than planned. In addition, although the implementation structure had room for improvement,

on-site technical instruction was provided in an effective and efficient manner. Therefore, the efficiency of the project is fair.

### 3.4 Sustainability (Rating: ③)

3.4.1 Related Policy towards the Project

As shown in Table 12, investments in the Programa as a percentage of investments in water supply projects are increasing year by year. Following completion of the project, activities for reducing the Non-Revenue Water Rate are being actively carried out at each business unit based on the Program. With an aim of reducing the Non-Revenue Water Rate in SABESP water service areas—which is the Overall Goal of the project—the sustainability of policy is evaluated as having been enhanced.

Table 12: Percentage of SABESP's Investment Plan Accounted for by Investments in the Programa

(Unit: Million real)

| | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| **Water supply projects** | **577** | **590** | **664** | **653** | **668** |
| Sewerage projects | 860 | 948 | 835 | 867 | 827 |
| Other | 214 | 213 | 254 | 228 | 231 |
| Total | 1,651 | 1,751 | 1,753 | 1,748 | 1,726 |
| **The Program**[1] | **181** | **267** | **310** | **328** | **478** |
| **The Program / Water supply projects** | **31%** | **45%** | **47%** | **50%** | **72%** |

Sources: SABESP Financial Statement (2008), Corporate Program for Water Loss Reduction (updated version, December 2013).

Note 1: 2009–2012: actual, 2013: planned.

3.4.2 Institutional Aspects of the Implementing Agency

Although there were no changes to the agency's organizational structure, the number of staff members decreased from 16,850 in 2007 to 15,049 in 2013. The reason for this decrease is that many staff members resigned once payment of pension benefits to active employees was disallowed.[36] The number of staff members fell to 15,103 in 2009, and has since been stable.[37] The number is unlikely to fall dramatically again. The employee retention rate is high, with many staff members being employed for 15 years or longer. Attempts have been made to raise the motivation of staff members, and this seems to be connected to the high retention rate. For instance, a department for managing non-revenue water was established, and staff members are paid a special bonus if the set target values for reducing non-revenue water are met.

One of the problems raised in the Project Completion Report was that functions were continuing to be outsourced without adequately developing the private-sector operators who take on the operations previously performed by SABESP. In response to the opinion that, from a long-term perspective,

[36] Previously, members of staff who continued to be employed even beyond the retirement age of 60 could receive both a salary and the pension. Following criticism of this, salaried workers were no longer able to receive the pension benefits.

[37] 15,330 (2010), 14,896 (2011), 15,019 (2012).

further efforts would be needed for building the technical capacity of private-sector operators, it was decided that certification testing based on the developed training program would be conducted by an external organization, ABES. In this way, the system for managing non-revenue water was further strengthened, and the creation of systems for developing private-sector operators was improved. Therefore, the institutional sustainability is high.

3.4.3 Technical Aspects of the Implementing Agency

According to the results of the interview and of the beneficiary survey of staff at Business Units in the pilot areas, it was confirmed that, in MO, more than half of the counterparts were still employed, and the transferred technologies had continued to be used for detecting leaks, testing water pressure and replacing distribution pipes and service pipes. In RS, only a few of the counterparts remained. Advances had been made in the control of non-revenue water for the Slums that had not been addressed during the project period, mainly by the department managing non-revenue water. In RV too, only a few of the counterparts continued to be employed, but after the completion of the project, technologies had been transferred to the younger staff members reassigned from other Business Units, and activities for controlling non-revenue water had been strengthened.

Table 13 shows the five challenges for improving technologies for reducing non-revenue water. Four of these five issues were dealt with in the project. The Japanese yen-loan project also covers four of the issues, and includes the following components. The technologies transferred in this project deal with technical issues for the SABESP measures to reduce non-revenue water, and they are also indispensable for the components of the Non Revenue Water Control Project in Sao Paulo State.

Table 13: Response to Technical Issues, and Components of the Non Revenue Water Control Project in Sao Paulo State

| Technical issue | Project response | Corresponding components of the Non Revenue Water Control Project in Sao Paulo State |
|---|---|---|
| Using water meters to ascertain real losses and apparent losses | Addressed in project | Replacement of service pipes at each household<br>Dealing with unauthorized use |
| Laying of service pipes and distribution pipes for expanding water supply, and improved quality of maintenance | Addressed in project | Replacement of distribution pipes |
| Shortage of experts to design and analyze pipe network | Addressed in project | Division of cities into sectors (DMCs) |
| Improvement of environment for investigating volume of loss (→ need recognized in this project) | Addressed in project | Detection of leaks using nondestructive testing, and repairs<br>Installation of pressure-reducing valves[38]<br>Installation of macrogauges<br>Setting of upper water pressure limit for small-capacity piping<br>Setting of lower water pressure limit for large-capacity piping |
| Understanding of the economic benefits of measures to reduce non-revenue water | Not yet addressed | Not included |

Source: Compiled by the evaluator based on the results of the interview from the TOR Department and of the beneficiary survey conducted during this Ex-Post Evaluation.

[38] A device for lowering the pressure of supplied water in the water-supply pipelines so that households can use water at an appropriate pressure.

Some of the transferred technology and provided equipment has diminished in usefulness. In situations where macrogauges (meaning devices for measuring the volume of water in a wide area supplied from water treatment plants) had not been installed, the portable electromagnetic flow meters[39] provided in fiscal 2007 and fiscal 2009 were regarded as a useful means of measuring the pressure and volume of water. However, at the time of the Ex-Post Evaluation, progress had been made in installing macrogauges in Service Area M in the Greater Sao Paulo region, and the need for the above flow meters here has lessened. It is expected that their use will be limited to Service Area R in the suburbs of the Greater Sao Paulo region where macrogauges have not yet been installed, and in regions where both flow rate and water pressure are low and so leaks cannot be detected using macrogauges. Thus, while the usefulness of the transferred technology and equipment has diminished in some areas as advances have been made in technology, they have responded by independently developing alternative technologies, and therefore the technical sustainability can be judged as having been strengthened.

3.4.4 Financial Aspects of the Implementing Agency

As shown in Table 14, SABESP's financial situation is good. Its operating profit margin in 2012 was greater than 26%, and its net income amounted to 1,911.9 million real. In conjunction with a growing awareness regarding the need for measures to reduce non-revenue water, it is expected that SABESP will continue to secure its required budget, and therefore, there are no problems with respect to financial sustainability.

Table 14: Summary of SABESP Financial Data, 2010–2012 (Unit: Million real)

| Summary of SABESP financial data | 2010 | 2011 | 2012 |
|---|---|---|---|
| Net operating income | 9,231.0 | 9,941.6 | 10,754.4 |
| Cost of operation and management, facilities, and maintenance | (5,194.5) | (6,031.1) | (6,465.4) |
| Gross profit | 4,036.5 | 3,910.5 | 4,289.0 |
| Selling expenses | (712.9) | (619.5) | (697.8) |
| Administrative expenses | (653.2) | (846.6) | (726.1) |
| Operating profit | 2,672.2 | 2,354.3 | 2,845.3 |
| Operating profit margin | 28.9% | 23.7% | 26.5% |
| Financial income (expenses), net | (379.4) | (633.6) | (301.4) |
| Net income | 1,630.5 | 1,223.4 | 1,911.9 |

Source: SABESP Annual Report (Form 20-F) (2012).

In light of the above, no problems have been observed in the policy background and the institutional, technical and financial aspects of the counterpart agency. Therefore, the sustainability of the project effects is high.

[39] A device for measuring the flow of conductive liquids (water), which is able to be moved or transported. In this project, the meters were loaded onto SABESP vehicles and moved to wherever necessary to measure flow.

## 4. Conclusion, Lessons Learned and Recommendations

### 4.1 Conclusion

The project was conducted with the aim of developing human resources and creating the systems needed to reduce non-revenue water at SABESP, in order to achieve the stable supply of water in the State of Sao Paulo.

Non-revenue water control has been one of the highest priority issues in the state which has a large population and scarce water resources. The project is also in line with the Brazilian development plan which aims at the effective utilization of water resources. Therefore, the project's relevance is high. There were some problems regarding the project implementation systems such as the insufficient number of local coordinators deployed. Nonetheless, technology transfer through OJT promoted communication between engineers and administrators, and led to non-revenue water control at the pilot areas. However, there were only limited activities to disseminate the output obtained at the pilot areas to the rest of SABESP's service area, and this negatively affected the Project Purpose achievement level. In contrast, SABESP strengthened its non-revenue water control based on the output obtained at the pilot areas. As a result, the Overall Goal is expected to be achieved. Therefore, the effectiveness/impact of the project is fair. Although the project period and the elements of inputs were mostly within the plan, the project cost slightly exceeded the plan. Therefore, the efficiency of the project is fair. SABESP is the largest business entity in Latin America with the fully equipped business implementation system and a high level of technology. It has good financial standing and is expected to allocate a budget for non-revenue water control into the future. Therefore, the sustainability of the project effects is high.

In light of the above, this project is evaluated to be satisfactory.

### 4.2 Recommendations

#### 4.2.1 Recommendations to the Implementing Agency

In implementing measures to reduce non-revenue water, the following two recommendations are offered.

The first recommendation is to establish clear standards regarding the definition and calculation of the volume of water for social purposes, and to promulgate this to all Business Units. At the time of the Ex-Post Evaluation, business operations were being conducted while these remained ambiguous. For the purpose of controlling non-revenue water, monitoring must be conducted based on a uniform definition and method of calculation, and then countermeasures must be examined based on the results of this monitoring.

The second recommendation concerns the promotion of measures to reduce non-revenue water in Slums. In this project, given that assistance in Slums is affected immensely by external factors, apart from some studies, they were excluded from the cooperation. Because the measures will require the involvement of the municipality, the police and other organizations, a strategy needs to be formulated based on a medium to long-term perspective, and an integrated action plan needs to be implemented.

4.2.2 Recommendations to JICA

After completion of the project, in an attempt to raise the bar for strengthening measures to reduce non-revenue water, SABESP took the training courses which had been demonstrated in the pilot areas and developed based on the many experiences and lessons learned, and introduced them into the national accreditation organization. In view of the need for measures to reduce non-revenue water in Brazil, it is recommended that JICA provide assistance for supporting dissemination of the knowledge and experiences accumulated in SABESP with regard to non-revenue water control, and for supporting the adoption by other states of the certification system introduced for strengthening non-revenue water control.

### 4.3 Lessons Learned

**(1) Consideration of measures for facilitating communication prior to the start of local operations**

At the start of the project, there were miscommunications between the Japanese side and the Brazilian side because of differences in language and culture, and these hindered various procedures at the preparatory stage. If the activities at MO could have been implemented sooner, it is possible that the knowledge and experience obtained from these activities would have been gleaned earlier, and even more transferred technology could have been applied to other pilot areas. In addition, the biggest challenge in this project—namely, dissemination of knowledge and experiences to other Business Units—could have been done more smoothly. Although this largely depends upon the communication skills of the counterparts and experts, in cases where such issues are envisaged, it is preferable that communication problems be prevented by assigning a person working as both interpreter and local coordinator, at Japan's expense, from the start of the project.

**(2) Formulation of plans attuned to the Project Purpose, and active use of local resources**

The aim of this project was to improve SABESP's overall non-revenue water control technology based on activities in the pilot areas. However, much of the limited resources were allocated to technical support in pilot areas, and inputs for dissemination were restricted. Ultimately, this negatively affected the achievement level of the Project Purpose. A major premise when forming a technical cooperation project is that consideration will be given to necessary and appropriate inputs in view of the objective, and that a reasonable plan will be formulated. Consideration should also be given to actively utilizing local resources and to taking consistency with the plan into account, for example, assigning experts who not only have technical competence but who are also proficient in dissemination activities. The appropriate assignment of counterparts is also an example of this. In cases where ambitious objectives are set with respect to the dissemination of technology, a mechanism for achieving this also needs to be incorporated into the project. During the project period, SABESP independently employed a local consultant, implemented a program called the Methods of Analysis and Solution for Water Losses and Non-revenue Water Problems (MASPP), and in the end, fostered an awareness for non-revenue water control among all Business Units. Although, in practice, these two

schemes were implemented separately, if the technical assistance provided through this project could have been incorporated into the MASPP, the capacity for non-revenue water control could have possibly been better enhanced across all Business Units.

**(3) Development of the best implementation structure for executing business operations**

SABESP's water service area is extremely vast, equivalent to the size of Honshu in Japan. The pilot areas are also several hundred kilometers apart. Despite the project covering such an extensive district, only one coordinator was assigned. Moreover, the coordinator was posted to the SABESP headquarters, and it was difficult for SABESP to grasp the situation in each district. This meant that there were often delays in confirming the progress of activities. In cases where the project target area is vast or where project sites are scattered, in order to conduct project operations smoothly, and in order to strengthen the transfer of technology in local areas, the most appropriate implementation structure should be developed, such as assigning coordinators from among staff members of the implementing agency who are working in each respective area.

**(4) Promotion of coordination between technical cooperation projects and yen loan projects, and the selection and concentration of assistance**

In non-revenue water control, both fundamental measures and preventive measures are important. During the project, it was suggested that, in addition to the technical cooperation project, ongoing support from Japan be sought to back up these preventive measures, and based on this suggestion, SABESP made a request for a yen-loan project. A project making use of a yen loan is able to immediately promote effective measures not possible in technical cooperation projects because of budgetary constraints, such as the large-scale replacement of distribution pipes and service pipes. This also served as an incentive to SABESP for non-revenue water control, and utilizing the human resources developed in the technical cooperation project, formulation of the Corporate Program for Water Loss Reduction was realized, and a training system that also included the private sector was built. Thus, combining support for "soft" components through technical cooperation projects together with support for "hard" components through yen loans is an effective means that also fits JICA's aid policy of selection and concentration.

**(5) Clearer definitions of indicators used in projects relating to measures to reduce non-revenue water**

According to the International Water Association (IWA) and the policy for supporting the international expansion of Japan's water supply industry,[40] non-revenue water is defined as the system input volume less the billed authorized consumption which has actually been charged. That corresponds to the Non Revenue Water Rate (NRW). In contrast, even while recognizing similar indicators to the IWA, SABESP uses non-revenue water rate (IPF) calculated by subtracting the

[40] Source: Ministry of Health, Labor and Welfare, "FY2009 Survey Report on International Contributions to Water Supply Services" (2009).

volume of water on a billed basis and the volume of water for social purposes from system input volume, as well as micro-measured water rate (IPM) calculated by subtracting the volume of water on an actual use basis and the volume of water for social purposes from system input volume. Water theft, such as water stolen in Slums, is recognized in the volume of water for social purposes, not in the volume of apparent losses.

In this project, taking into account Brazil's specific circumstances, micro-measured water rate (IPM) was used as the evaluation index, and the volume of apparent losses in Slums was included in the volume of water for social purposes. However, in the Ex-Ante Evaluation Report and the Project Completion Report, the definition of non-revenue water has been used ambiguously in statements, NRW and IPM have been mixed together, and the definition of the volume of water for social purposes has not been clearly stated. To get an accurate understanding of the project effects, it is imperative that target values be monitored and reports prepared with an awareness of how these indicators are defined and distinguished.

End.

Federative Republic of Brazil

Ex-post Evaluation of Japanese Technical Cooperation Project

Northeast Water Resources Development Project

External Evaluators: Yuko Kishino / Noriaki Suzuki, IC Net Limited

## 0. Summary

The northeast region is characterized by hot and dry climate and is known as the driest region in Brazil. This project aims to supply safe drinking water to local people stably by constructing water supply facilities in the region. Its relevance is high because the aim is consistent with the Brazilian Government's policies and development needs and Japan's aid policy. Of the three states where subprojects were supposed to be carried out under this project, the water supply population has steadily grown to 50,000 in Bahia State and 200,000 in Sergipe State. The exception is Ceara State, which eventually received loans under the Growth Acceleration Program (Programa de Aceleração do Crescimento; hereinafter referred to as "PAC"). According to the results of a survey on the beneficiaries in Bahia State, many people's health condition improved because of improvement in water quality, and the subproject is highly satisfactory. In Sergipe State, the subproject has promoted the supply of water to 25 cities among the 75 cities in the state, and the effect of the subproject extends over a wide area, such as planning the distribution of water to basins along the Sergipe River, where demand for water supply is the highest. In this way, this project greatly contributes to water supply in the dry region, and the effectiveness and the impact are high. With regard to the efficiency, it took much time to receive approval for the subprojects, and the construction period was prolonged because of an expansion of the scope, with the result that the project duration and cost greatly exceeded the estimates. After the completion of the project, the facilities were transferred to public water utilities in each of the states, and no problem has occurred with regard to the systems and technologies of the utilities in charge of the management and maintenance of the facilities. The financial conditions are good, because the profitability of all the implementing agencies in Bahia State is high and Sergipe State has been subsidized. Therefore, the sustainability of the effects that emerged from this project is high.

In light of the above, this project is evaluated to be satisfactory.

## 1. Project Description


Map of project sites

An intake and purification plant for a Semi-Arid water supply system

### 1.1 Background

In the National Water Resources Law (Law 9433/97), which was promulgated in January 1997, the Brazilian Federal Government provided that a comprehensive system for the development and management of water resources[1] should be created for each basin to use water resources efficiently. Subsequently, in ten states that needed efficient use of water resources more than the other states (nine northeast states and one southeast state[2]), the Federal Water Resources Management Project (hereinafter referred to as "PROAGUA")[3] was planned to be carried out with the cooperation of the World Bank. The main purposes are as follows: 1) integration with the management of the water resources throughout the country through the strengthening of the organization of management of water resources and the improvement of the methods for the management; 2) promotion of the effective and efficient management of water resources through the strengthening of the states' autonomy and the participation of the residents; and 3) establishment of water infrastructure that is highly sustainable in terms of natural and social environments and economic aspects.

During the appraisal, it was decided that yen loans should be given to the part of the whole PROAGUA program that the Brazilian Federal Government had approved. The States of Ceara, Bahia, and Sergipe were selected as candidates, and loans were planned to be given for the construction of water supply facilities. By 2005, the subprojects in the three states were approved as those under this project.

---

[1] The system for the development and management of water resources placing priority on the supply of drinking water with comprehensive consideration on water demand in each region.

[2] Alagoas, Bahia, Ceara, Maranhão, Sergipe, Paraíba, Pernambuco, Piauí, and Rio Grande do Norte (in the northeast region); Minas Gerais (in the southeast region)

[3] The Overall Goal is to improve the quality of life through the effective and efficient management of water resources and realize the sustainable provision of high-quality water through promotion of the expansion and improvement of the water infrastructure. In 2000, the program started with a budget of 330 million dollars (198 million dollars from the World Bank and 132 million dollars from the Federal Government) and was to be completed in 2006. The program period was extended by two years in 2003 and by one year in 2005 and, as a result, was completed in 2009. The total program cost was 291 million dollars (158 million dollars from the World Bank and 133 million dollars from the Federal Government).

### 1.2 Project Outline

The objective of this project is to provide stable supply of safe water in the northeast region by constructing water supply facilities (such as water intake facilities, water transmission facilities, purification plants, and distribution reservoirs), thereby contributing to the improvement of the living environment of local people.

| | |
|---|---|
| Loan Approved Amount/ Disbursed Amount | 3,595 million yen / 3,486 million yen |
| Exchange of Notes Date/ Loan Agreement Signing Date | April 30, 2003 |
| Terms and Conditions | Interest rate for public works: 2.5%<br>Interest rate for consulting services: 1.8%<br>Repayment Period: 25 year<br>(Grace Period: 7 years)<br>Conditions for Procurement: general untied |
| Borrower / Executing Agency | Federative Republic of Brazil / Ministry of National Integration |
| Final Disbursement Date | September 26, 2008 |
| Main Contractors (Over 1 billion yen) | MRM - Construtora S/A, Construtora Celiltda./Imobiliaria Rocha Ltda., Amitech Brasil Tubos Ltda. (Brazil); Amitech Spain S.A (Spain) |
| Main Consultants (Over 100 million yen) | Astef-Associacao Tecnico-Cientifica Engenheiro Paulo De Fron/VBA Consultores Ltda, UFC Engenharia Ltda./SIGA-Sociedade De Incentivo E Apoio Ao Gerenciamento Ambient/Tahal Consulting Engineer Ltd., Enpro-Engenharia De Projetos E Obras Ltda./Consenso Projetos E Servicos Ltda (Brazil) |
| Feasibility Studies, etc. | F/S by the Federal Government is unknown. |
| Related Projects | ・ Project for the Management of Non-Revenue Water, technical cooperation (2007–2010)<br>・ Non-Revenue Water Control Project in Sao Paulo State, yen-loan project (L/A 2012)<br>・ PROAGUA, World Bank (1998–2009) |

## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Yuko Kishino, IC Net Limited

Noriaki Suzuki, IC Net Limited

### 2.2 Duration of Evaluation Study

The ex-post evaluation study was carried out as follows:

Duration of the Study: September 2013 – January 2015

Duration of the Field Study: December 6 – December 7, 2013; January 20 – February 12, 2014; May 20 – May 28, 2014

### 2.3 Constraints during the Evaluation Study

PROAGUA is a national program whose purpose is to strengthen systems for the management and use of water resources. This yen-loan project is to finance PROAGUA in cooperation with the World Bank. At the time of the appraisal (in April 2003), among the ten target states of PROAGUA, three states – the States of Bahia, Ceara, and Sergipe – were selected as candidates. In this ex-post evaluation, it was decided that an ex-post evaluation should be carried out in the three states because details of the World Bank's financing have not been described in the appraisal materials prepared by the Japan International Cooperation Agency (hereinafter referred to as "JICA") and because it is possible to evaluate the portion of this yen-loan project separately.

However, the ex-post evaluation found that, after official consent was given to the subprojects in the three candidate states, the subproject in Ceara State was not agreed between the State's water resources agency and the bidding companies in 2007 and the time limit for financing came while the bidding remained cancelled, with the result that the plan was greatly expanded by PAC's financing and was in progress at the time of the ex-post evaluation.

As a result, it is judged appropriate to exclude the subproject in Ceara State from the targets of the evaluation and limit the description of the relevance and efficiency, about which partial information could be gained, to the description of the results of the confirmation of facts. This is because of the following: (1) although the three subprojects were planned at the time of the appraisal, it was assumed that applications for other subjects would be filed after the conclusion of the yen-loan agreement; (2) yen loans were not used for the construction under the subproject in Ceara State; (3) the subproject was incomplete at the time of the ex-post evaluation (in November 2013); and (4) it was difficult to collect information from relevant agencies because of (2) and (3) above.

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

### 3.1 Relevance (Rating: ③[5])

#### 3.1.1 Relevance to the Development Plan of Brazil

(1) Development plan at the time of the appraisal

In a national development plan called the "Multi-Year Plan (Plano Plurianual de Acao; hereinafter referred to as "PPA"), the Brazilian Government designated PROAGUA as one of the priority 54 strategic programs. Its purpose was to manage water resources effectively and efficiently and provide high-quality water sustainably in the northeast region, where the need for the development of water resources is high. The No Starvation Program, which was published in January 2003, aimed to construct the basic living infrastructure in the northeast region, where the number of poor people is large and economic development has been delayed, listing five priority items: 1) farmland reform; 2) family farming support; 3) emergency support to semi-arid areas; 4) civic education; and 5) employment creation. PROAGUA falls under 3) and this project is a part of PROAGUA. Because the purpose of this project is to supply purified water safely and stably, the relevance to the development policy was high at the time of the appraisal.

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

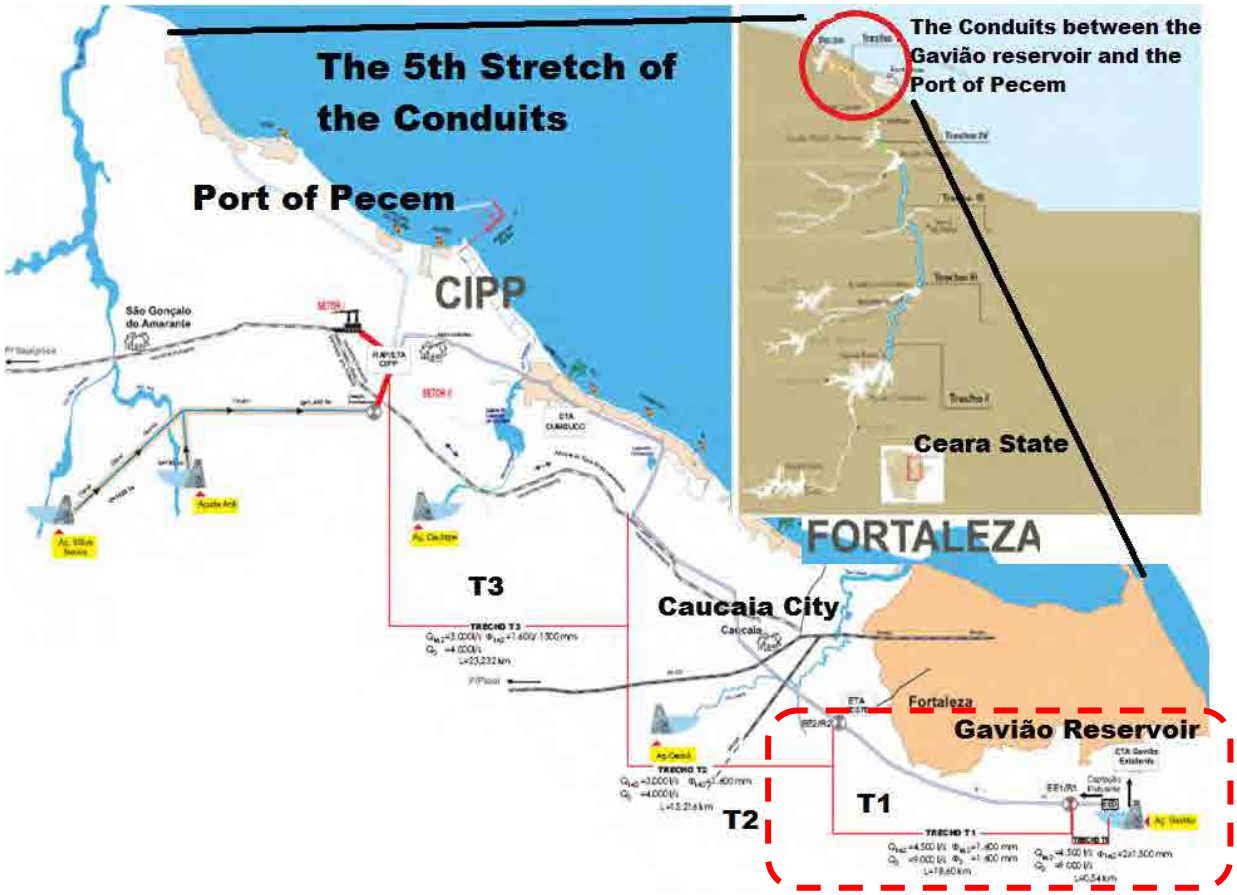
In "PPA 2012–2015," the national development plan at the time of the ex-post evaluation, the expansion of water supply to the northeast region continues to be regarded as an important item. In the National Water Resources Development Plan until 2020,[6] the Advisory Committee on Water Resources and Nature regards the insufficient supply of drinking water during the dry season in the region as a serious problem and adopted a main strategy of using basins across semi-arid areas for the improvement of the water infrastructure and the expansion of water supply. In the No Starvation Program, priority continues to be placed on the above-mentioned five items and, at the time of the ex-post evaluation, one of the five main programs[7] is the rainwater purification support program in the northeast region. In this way, the purpose of this project – the improvement of the water infrastructure and the expansion of water supply in the northeast region – is consistent with the national policy and is highly relevant.

(3) Development policy in the target states

Ceara State: In 1992, under the state ordinance 11.996/92, Ceara State came out with a comprehensive water resources management plan. Every four years since then, it has established a water resources management strategy and a development plan, predicted water demand in each basin area in the state, and planned measures and projects accordingly. This includes the strengthening of

[4] A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory
[5] ③: High; ② Fair; ① Low
[6] 2006.
[7] The low-income earner support program, the school meal program, the family farming support program, the food acquisition program, and the rainwater purification support program in the northeast region.

water supply to the state capital metropolitan area of Fortaleza[8] and the installation of conduits that connect the Gavião reservoir and the Port of Pecem. As a part of this water transmission plan, this subproject aims to supply drinking water to the western part of the capital district and the coastal district (Figure 1 T0-T1) and is consistent with the state's development needs. At the time of the ex-post evaluation, with progress in economic development, water demand has become higher in the Fortaleza metropolitan area and the districts around the Port of Pecem.

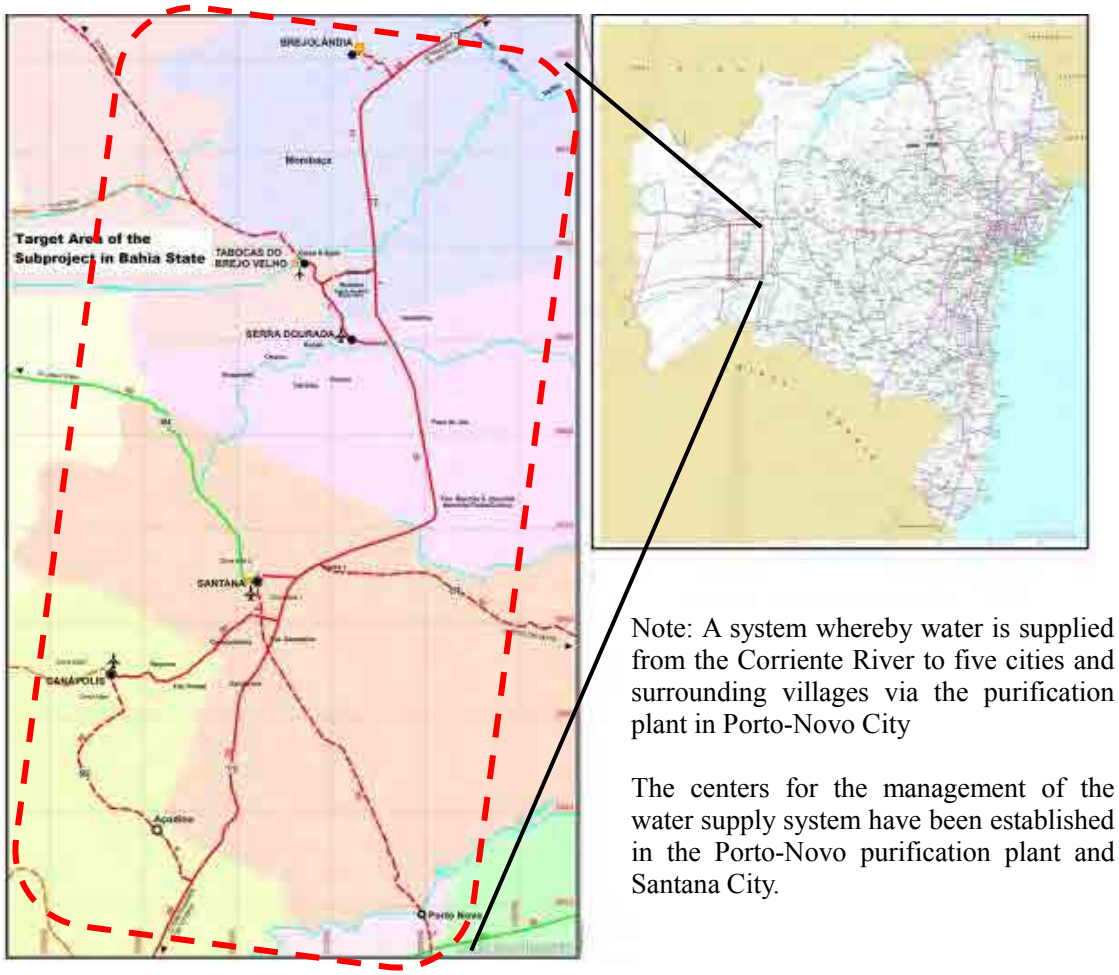



Source: Detailed design document for the Conduit Installation Project between Gavião reservoir and the Port of Pecem

Figure 1: Target Area of the Subproject in Ceara State

Bahia State: In 1995, under the state ordinance 6855, the State Basin Management Committee was founded for the management of water resources and a plan to manage and develop water resources was established for the 17 main basins in the state between 1995 and 1997. This subproject is related to the plan to manage and develop water resources in the Corriente River basin. In 2003, a plan to manage water resources (Plano Estadual de Recursos Hídricos: hereinafter referred to as "PERH") for Bahia State was established, including 5-year, 10-year, and 20-year plans. At the time of the ex-post evaluation also, development is in progress under PERH, adopting the main strategy of managing and effectively using the 17 basins. Figure 2 shows the target area of the subproject.

[8] It accounts for 62% of the total water supply demand in the state as of 2000.

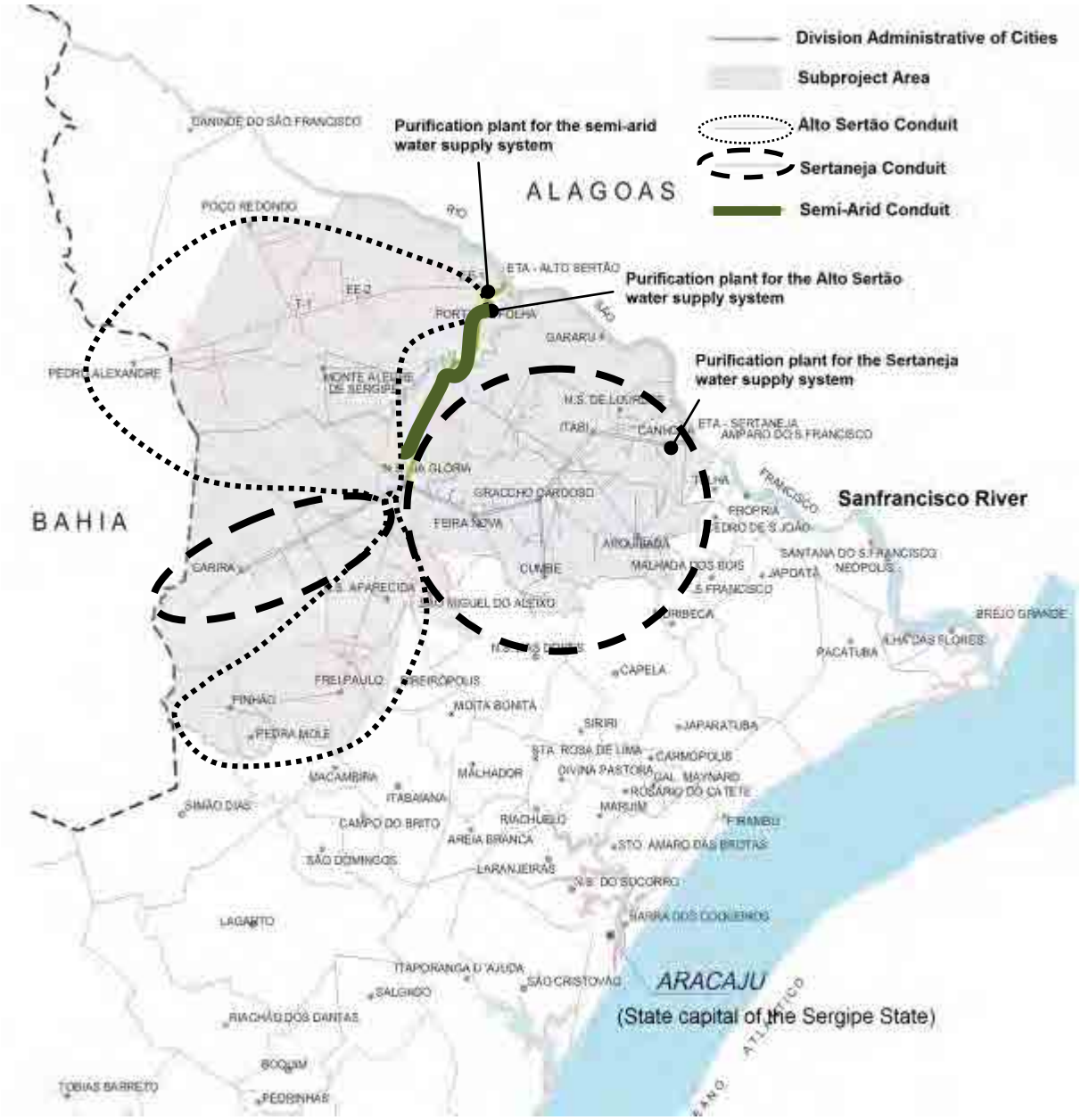



Source: Project Completion Report for the PROAGUA Subproject in Bahia State (The water supply system for Santana City, Canapolis City, Serra Dourada City, Tabacos do Brejo Velho City, Brejolândia City)

Figure 2: Target Area of the Subproject in Bahia State

Sergipe State: In 1997, Sergipe State formulated a policy for managing water resources pursuant to the state ordinance 3870. In 2007, the State's water resources agency (Secretaria do Meio Ambiente e dos Recursos Hídricos; hereinafter referred to as "SEMARH") established a water resources management system pursuant to the state ordinance 6130. In 2010, PERH was established under PROAGUA. The PERH consists of 27 subprojects and has the following purposes: (1) analysis of water resources in the state and identification of the most suitable method for water use; (2) establishment of a sustainable system for the management of water resources based on the results of the analysis of water resources and the identification of their methods of use; (3) construction of the water infrastructure based on the analysis in (1) and (2) above and the water resources management system; and (4) disclosure of information on the status of the management of water resources and the improvement of water resources management literacy. This subproject is related to the water infrastructure construction projects under the Baixo Rio Sanfrancisco basin management plan and the Fos do Rio Sanfrancisco basin management plan. The goal is to supply high-quality fresh water from

the Sanfrancisco River to the Alto Sertão district and the Semi-Arid district in the semi-arid area. Because this subproject contributes to the improvement of local people's living environment, its relevance is extremely high.




Source: Water Resource Management Plan for the Alto/Medio Sertão region and Rio Sanfrancisco basin
Note: The target area extends to 8,837 square meters and includes 25 cities. The green part is the Semi-Arid conduit, the brown part is the Alto Sertão conduit, and the blue part is the Sertaneja conduit. The central city where these three conduits intersect is Nossa Senhora da Gloria.

Figure 3: Target Area of the Subproject in Sergipe State

### 3.1.2 Relevance to the Development Needs of Brazil

The northeast part of Brazil – especially, the inland part – is characterized by a hot and dry climate

and is known as a semi-arid district.[9] As shown in Table 1, all the states in the northeast part except the State of Maranhão include many semi-arid areas. Semi-arid areas occupy more than a half of the total area of the State of Minas Gerais in the southeastern part of Brazil, which is covered by PROAGUA. The expansion of water supply to semi-arid districts is needed by the whole country of Brazil. As shown in Table 2, the diffusion of water supplies in the three target states was 61% to 74% in 2000, lower than the national average of 78%. Because it was lower than the national average also in 2011, it is necessary to expand the provision of water supply.

In the target states, some districts not only lacked water supply, but also needed improvement of the water quality because of supply of water with a hardness that is unsuitable for drinking or groundwater with high salinity. The people in these districts had to purchase drinking water from water trucks and shouldered a heavy economic burden. The use of groundwater with high hardness caused the adhesion of scale[10] to the water supply facilities, and the accumulation of scale hindered the maintenance of the water supply facilities. To improve the situation, it is essential to use water resources effectively in the northeastern part – that is, to establish a comprehensive system for developing and managing water resources in accordance with the demand in each district.

Table 1: Number of Cities Designated as Semi-Arid Districts

| State | No. of cities | No. of semi-arid cities | Ratio to the total number in Brazil | Ratio to the total number of cities in the state |
|---|---|---|---|---|
| Piaui | 221 | 127 | 11.2% | 57.5% |
| Ceara | **184** | **150** | **13.2%** | **81.5%** |
| Rio Grande do Norte | 166 | 147 | 13.0% | 88.6% |
| Paraíba | 223 | 170 | 15.0% | 76.2% |
| Pernambuco | 185 | 122 | 10.8% | 65.9% |
| Alagoas | 101 | 38 | 3.4% | 37.6% |
| Sergipe | **75** | **29** | **2.6%** | **38.7%** |
| Bahia | **415** | **265** | **23.4%** | **63.9%** |
| Maranhão | 217 | 0 | 0% | 0% |
| Whole of the northeastern part | **1,787** | **1,048** | **92.5%** | **58.6%** |
| Minas Gerais (Southeast of Brazil) | 165 | 85 | 7.5% | 51.5% |

Source: Selection of cities designated as semi-arid districts (Ministry of National Integration; March 2005)

[9] A semi-arid district is defined as a city that satisfies all the following conditions: 1) annual rainfall is 800 mm or less; 2) the potential evapotranspiration is more than twice and less than five times as high as the rainfall according to the results between 1961 and 1990; 3) the risk of aridity is more than 60% according to the results between 1970 and 1990.

[10] Calcium and magnesium deposited in the water

Table 2: Water Supply Diffusion in the Target States of This Project (Unit: %)

| Year | 2000 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|
| Bahia State | 72.8 | 71.2 | 71.7 | 74.4 | 69.4 | 71.4 | 74.4 | 75.8 | 78.6 |
| Ceara State | 61.4 | 60.6 | 60.3 | 60.5 | 59.4 | 59.9 | 59.2 | 62.5 | 72.9 |
| Sergipe State | 74.3 | 73.6 | 74.1 | 72.9 | 79.0 | 80.8 | 76.2 | 81.3 | 81.6 |
| National average | 78.2 | 77.5 | 77.1 | 77.4 | 80.4 | 81.1 | 78.9 | 81.1 | 82.4 |

Source: calculated based on SNIS (Brazil's National Information System on Water, Sanitation and Solid Waste)

#### 3.1.3 Relevance to Japan's ODA policy

During the Third World Water Forum in 2003, the Japanese Government stated that, as the chair, Japan would support efforts by countries that have water problems. Given the worsening of the residential environment as a result of urbanization and conspicuous gaps between the rich and the poor and among districts, the Medium-Term Strategy for Overseas Economic Cooperation Operations (2002–2004) designated "projects for environmental conservation" and "support for economic infrastructure development, social sectors, and poverty measures for the correction of income gaps and regional gaps" as priority support sectors. Of the environmental sectors, the support to the water supply and sewerage sector had attained many achievements, and was expected to contribute to the improvement of the living environment. To eliminate regional gaps, it was announced that the direction of the support was to place importance on support for the development of infrastructure in districts with many poor people and improve the quality of life. Because the goal of this project is to establish water supply systems and contribute to the improvement of the living environment in the northeast part of Brazil, where aridity is severe and water resources are insufficient, this project is highly relevant to Japan's ODA policy.

This project has been highly relevant to the country's development plan, development needs, as well as Japan's ODA policy. Therefore its relevance is high.

### 3.2 Effectiveness (Rating: ③)

#### 3.2.1 Quantitative Effects (Operation and Effect Indicators)

At the time of the appraisal, standard values for operation and effect indicators and target values were not set. Accordingly, when the Ministry of National Integration made an agreement with each state government about the subproject, 1) the performance for the target number of beneficiaries, which is the only item for which the target value was set, was confirmed. It was decided that effectiveness would be judged from the following three points in addition to 1) above: 2) whether there is a great gap in the ratio of water supply population between the public water corporation's service areas and the target areas of the subproject in each state; 3) whether each state's operation rate of water purification facilities has reached the level at which they can be judged to be appropriate; and 4) whether the quality of purified water has satisfied the national criteria.

(1) Bahia State

Before the beginning of the subproject, water was drawn from wells constructed in 1974, purified by simplified equipment, and used for everyday life. In some districts in four out of the five target cities (i.e., except Tabacos do Brejo Velho City), water that was drawn from wells and injected with chlorine was supplied to each household through distribution and supply pipes. However, in most districts, water was distributed at chlorine injection facilities. In Tabacos do Brejo Velho City, water trucks came from the city hall and distributed water to local people free of charge, because this city is not an area covered by the Bahia State's public water corporation (Empresa Baiana de Águas e Saneamento S.A.; hereinafter referred to as "EMBASA"). Since the implementation of the subproject, water has been supplied from purification facilities to each household through supply pipes in all these cities.

Figure 4: Porte-Novo Purification Plant

Figure 5: Water Supply Tank in Santana City

Table 4: Operation and Effect Indicators for the Subproject in Bahia State

| Indicator | Unit | Definition | At the time of appraisal in 2003 | At the time of agreement on the subproject in 2003[11] | 2012[12] (Resultant value) (2 years after completion) | 2013 (Resultant value) (5 years after completion) |
|---|---|---|---|---|---|---|
| | | | Target value | Target value | | |
| Amount of water supply* | $m^3$/ day | Maximum amount per day | No fixed value | No fixed value | 6,510 | 5,950 |
| | | Average amount per day | No fixed value | No fixed value | 6,140 | 5,190 |
| Water supply per person | l/ day | Daily maximum amount per person | No fixed value | No fixed value | 138 | 103 |
| | | Daily average amount per person | No fixed value | No fixed value | 126 | 89 |
| Equipment operating rate | % | Daily maximum purification / purification capacity | No fixed value | No fixed value | 53 | 56 |
| Population in the water supply area | Persons | Total population in areas where water services are available | No fixed value | No fixed value | 74,780 | 79,130 |
| Water supply population | Persons | Water supply population in the target areas | 50,000[13] | 65,000[14] | 48,781 | 58,191 |
| Water supply population ratio | % | Water supply population / population in areas where water services are available | No fixed value | No fixed value | 53 | 74 |

Source: Compiled by the evaluators based on questionnaire answers from the Bahia State's water resources agency, EMBASA, etc.
Note: * The amount of water supply from the purification plant

(i) Performance in terms of the number of beneficiaries

When the subproject was agreed in 2003, the target number of beneficiaries was set at 65,000. Because the resultant number of beneficiaries in 2010 was 48,781, the performance is 75%. The resultant number is less than planned because the connection to each household was delayed in Tabacos do Brejo Velho City. Since the city was not within the water supply area of EMBASA before the implementation of the subproject and received water from the city government free of charge, it can be assumed that some households would have hesitated to shift to the paid water supply system. The water supply population increased year by year to 54,330 in 2011, 56,531 in 2012, and 58,191 in 2013. It reached 90% of the target in 2013. As shown in Table 4, the amount of water supply and that per person in 2013 decreased from 2010. This is a result of EMBASA's measures for stopping water leaks from water supply pipes and water distribution pipes and shows that the loss of water supply

[11] In 2003, with regards to the project scale (the number of beneficiaries and the project cost), a written agreement entitled "Convenio MI/SIH-080/2003-SIAA de Santana" was concluded between the Ministry of National Integration's Water Infrastructure Agency, the federal government's PROAGUA unit, and Bahia State's water resources agency (Secretaria do Meio Ambiente: hereinafter referred to as SEMA), the state government's PROAGUA unit. In that year, JICA also agreed on the same project scale.
[12] In Bahia State, the target values set when the subproject was agreed are compared with those in 2010, two years after the completion of the project in 2008.
[13] The estimated number of beneficiaries of the subproject. Sources: Ministry of National Integration's PROAGUA and JICA's internal documents
[14] The estimated number of beneficiaries of the subproject specified in the written agreement on the subproject between the Ministry of National Integration and the Bahia State Government (2003).

from the purification plant decreased and the water supply became efficient.[15]

(ii) Water supply population ratio in the subproject areas

As shown in Table 5, the water supply population ratio in the areas covered by the subprojects in 2013 was 74% and reached the level of 2009 in the areas covered by the EMBASA service in Bahia State. It shows high growth in these areas: a 12% increase between 2009 and 2010 and an 8% increase between 2010 and 2011. Therefore, it can be judged that water supply has been steadily spreading.

Table 5: Water Supply Population Ratios in the Subproject Areas and the EMBASA Service Areas

| Bahia State | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| Subproject area | --- | --- | --- | --- | □-- | 53% | 65% | 73% | 74% |
| EMBASA service area | 72% | 73% | 74% | 71% | 71% | 74% | 74% | 78% | - |

Source: Calculated by the evaluators from the Brazil's National Information System on Water, Sanitation and Solid Waste (SNIS)

(iii) Equipment operating rate

The equipment operating rate is 56% in 2013. It has gradually increased from 52% in 2009, the year following the beginning of operations, and 53% in 2010. It is a little less than Japan's national average of 60.63%.[16] This is because the equipment has been designed so as to keep up with the increase in the population until 20 years after installation and because, at the time of the ex-post evaluation, pump motors stopped during the time zone between 7:00 p.m. to 10:00 p.m., when a high electricity rate was applied. Because, with the population increasing, the equipment operating rate is expected to increase and because the hours of water supply have been set according to the local minimum needs to cut down management and maintenance costs,[17] the equipment operating rate at the time of the ex-post evaluation is judged to be appropriate.

(iv) Water quality

EMBASA has collected 250 to 300 samples every month to carry out water quality inspections. As shown in Table 6, the representative indicators for water quality in 2013 satisfy Brazil's national standards throughout the year.

[15] According to the results of water meter measurement, the daily total amount of water supply to households increased from 3,132 $m^3$ in 2010 to 4,007 $m^3$ in 2013.

[16] Ministry of Internal Affairs and Communications business management indicators in FY2012

[17] If local people's incomes increase and the amount of water use per person increases, the pumps operated for 21 hours a day at the time of the ex-post evaluation can be operated for 24 hours a day.

Table 6: Results of Water Quality Inspections in Santana City in Bahia State (2013)

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water color Note 1 (degrees) | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Residual chlorine content Note 2 (mg/l) | 2.5 | 1.5 | 2.0 | 0.5 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 |
| Colon bacilli Note 3 (%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Source: EMBASA
Note 1: According to Brazil's national standards, water color[18] should be 15 degrees or less.
Note 2: According to Brazil's national standards, the residual chlorine content should be 0.2 to 2 mg/l.
Note 3: According to Brazil's national standards, colon bacilli should not be found in 95% of samples (100 ml). The figures in the table are the proportion of samples in which colon bacilli were found from all samples (100 ml).

(2) Sergipe State

Before the implementation of the subproject, the target 15 cities distributed water to households through the existing Alto Sertão water conveyance system and the existing Sertaneja water conveyance system under the jurisdiction of Sergipe State's public water corporation (Companhia de Saneamento de Sergipe; hereinafter referred to as "DESO"). The systems did not cover the whole of each city. In the remaining districts, water was supplied from wells or water trucks. To increase the amount of water distribution, the two water conveyance systems were repaired, such as through the improvement of electric power systems, automatization of the water conveyance systems, and the replacement of pump motors, and a new semi-arid water conveyance system was constructed. As a result, the amount of water distribution increased and it became possible to satisfy water demand in 25 cities in four areas.[19] Water became available for 18 hours a day. Supplementary water supplies have also been planned for basins along the Sergipe River in the central part, which is not covered by the subproject, but has a high demand for water.

Figure 6: A Water Supply Tank for the Alto Sertão Water Conveyance System

Figure 7: A Pump Station for the Semi-Arid Water Conveyance System

[18] Water color is the degree of colorization by substances in the water. The water color is one degree when 1 ml of a standard water color liquid (1 mg of platinum or 0.5 mg of cobalt) is added to 1,000 ml of water.
[19] The Alto Sertão area, the semi-arid area, the central Agreste area, and the low coastal area of the Sanfrancisco River.

Table 7: Operation and Effect Indicators for the Subproject in Sergipe State

| Indicator | Unit | Definition | At the time of the appraisal in 2003 | At the time of agreement on the subproject in 2004[20] | 2013[21] (Resultant value) | 2014[22] (Estimated value) |
|---|---|---|---|---|---|---|
| | | | Target value | Target value | | |
| Amount of water supply | $m^3$/ day | Maximum amount per day | No fixed value | No fixed value | 64,150 | 74,760 |
| | | Average amount per day | No fixed value | No fixed value | 58,430 | 59,700 |
| Water supply per person | Per day | Daily maximum amount per person | No fixed value | No fixed value | 295 | 372 |
| | | Daily average amount per person | No fixed value | No fixed value | 297 | 290 |
| Equipment operating rate | % | Daily maximum purification / purification capacity | No fixed value | No fixed value | 92 | 92 |
| Population in the water supply area | Persons | Total population in areas where water services are available | No fixed value | No fixed value | 222,693 | 226,602 |
| Water supply population | Persons | Water supply population in the target areas | 200,000[23] | 200,000[24] | 197,063 | 201,124 |
| Water supply population ratio | % | Water supply population / population in areas where water services are available | No fixed value | No fixed value | 88.49 | 88.76 |

Source: Compiled by the evaluators based on questionnaire answers from the Sergipe State Water Agency and DESO.

(i) Performance in terms of the number of beneficiaries

When the subproject was agreed in 2004, the target number of beneficiaries was set at 200,000. Because the resultant number of beneficiaries in 2013 was 197,063, the performance is 99%. The number of beneficiaries is estimated to increase to 201,124 in 2014 because the pump motor at the intake point of the Semi-Arid water conveyance system is planned to be strengthened. Based on PERH, it has been planned that water will be distributed to basins along the Sergipe River in the central part. It has been expected that the high-quality water in the Sanfrancisco River can be distributed throughout Sergipe State and greatly contribute to the expansion of water supply districts in the semi-arid area.

(ii) Water supply population ratio in the subproject areas

As shown in Table 8, the water supply population ratio in the subproject areas was 88% in 2013. Since 2009, it has been higher than that of the entire DESO service areas. Because DESO has continued to connect water pipes to each household and expand the water distribution networks

[20] In 2004, with regard to the project outline, a written agreement entitled "Convenio MI/SIH-314/2004-Alto Sertao e Sertaneja" was concluded between the Ministry of National Integration's Water Infrastructure Agency, the federal government's PROAGUA unit, and SEMARH, the state government's PROAGUA unit. In the following year, JICA also agreed on the same project outline.

[21] In Sergipe State, the target values set when the subproject was agreed are compared with those in 2013, two years after the completion of the project in 2011.

[22] For reference, values in 2014, three years after the completion, were added as estimates.

[23] The estimated number of beneficiaries of the subproject. Source: Ministry of National Integration's PROAGUA and JICA's internal documents

[24] The estimated number of beneficiaries of the subproject specified in the written agreement on the subproject between the Ministry of National Integration and the Sergipe State Government (2004).

independently, the subproject strived to increase water supply population by using those existing facilities. It can be judged that the goal for this indicator has been achieved because the diffusion rate is higher than the average for all the service areas.

Table 8: Water Supply Population Ratios in the Subproject Areas and the DESO Service Areas

| Sergipe State | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| Subproject areas | 76% | 76% | 76% | 83%[Note 1] | 87% | 87% | 89% | 88% |
| DESO service areas | 73% | 76% | 76% | 77% | 78% | 78% | 80% | 80% |

Source: Calculated by the evaluators from DESO's questionnaire answers
Note 1: Because some of the water conveyance systems to be repaired began to operate in 2009, improvement has been seen since that year.

(iii) Equipment operating rate

The operating rate for all the water conveyance systems was 92% in 2013. Because it had already reached a high level, it can be judged that the initial goal has been achieved.

(iv) Water quality

DESO has collected 850 to 1,000 samples every month to carry out water quality inspections. As shown in Table 9, the representative indicators for water quality in the Sertão area in 2013 satisfy Brazil's national standards throughout the year.

Table 9: Results of Water Quality Inspections in the Sertão Area in Sergipe State (2013)

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water color [Note 1] (degrees) | 8 | 5 | 4 | 4 | 4 | 4 | 5 | 5 | 4 | 4 | 5 | 5 |
| Residual chlorine content [Note 2] (mg/l) | 1.4 | 1.6 | 1.4 | 1.6 | 1.5 | 1.7 | 1.5 | 1.5 | 1.5 | 1.7 | 1.7 | 1.6 |
| No. of colon bacilli [Note 3] (%) | 2.2 | 0.6 | 0.6 | 0.7 | 3.2 | 0.5 | 0.4 | 0.8 | 3.4 | 1.8 | 1.4 | 1.4 |

Source: Calculated by the evaluators based on DESO's monthly reports on water quality monitoring in 2013
Note 1: According to Brazil's national standards, water color[25] should be 15 or less.
Note 2: According to Brazil's national standards, the residual chlorine content should be 0.2 to 2 mg/l.
Note 3: According to Brazil's national standards, colon bacilli should not be found in 95% of the samples (100 ml). The figures in the table are the proportion of samples in which colon bacilli were found from all the samples (100 ml).

### 3.2.2 Qualitative effects

The qualitative effect assumed at the time of the appraisal is improvement of the local people's living environment. Because the qualitative effect is an impact under this project, it will be analyzed in the next section.

[25] Water color is the degree of colorization by substances in the water. Water color is one degree when 1 ml of a standard water color liquid (1 mg of platinum or 0.5 mg of cobalt) is added to 1,000 ml of water.

## 3.3 Impact

### 3.3.1 Intended Impacts

The impact assumed at the time of the appraisal was the "improvement of local people's living environment." To check this, a beneficiary survey[26] and an interview survey were carried out in Bahia State and an interview survey was carried out in Sergipe State. The survey results are as follows:

(1) Bahia State

As described above, before the implementation of the project, the subproject areas used water purified by simplified facilities. Because the hardness was high (with a high content of magnesium and calcium), the quality of the water was low for use in daily life. In addition, the water supply facilities were damaged by substances accumulated in the distribution pipes. It was confirmed that this project made it possible to supply high-quality drinking water, resulting in improvement of the living environment. Table 10 shows the main results of the beneficiary survey.

Table 10: Results of a Survey of the Beneficiaries of the Subproject in Bahia State (150 samples)

| Are you satisfied the water supply system? | | Has the quality of drinking water improved? | |
|---|---|---|---|
| Satisfied | 95% | Improved | 89% |
| Not satisfied | 5% | Not changed, worsened | 11% |
| Has the improvement of the water quality contributed to any improvement of your health? | | Has time been saved? | |
| Contributed | 99% | Saved | 55% |
| Not contributed specially | 1% | Not saved | 45% |
| Is the water supply sufficient? | | Are there any problems with the water supply system installed under this project? | |
| Sufficient | 90% | There is a problem | 20% |
| Insufficient | 10% | No problem | 80% |
| Has the water rate been raised? | | Can you fully cover the water rate? | |
| Raised | 85% | I can fully cover it | 72% |
| Not raised | 14% | Difficult to cover it | 27% |
| I don't know | 1% | I don't know | 1% |

Source: Compiled by the evaluators based on the results of the survey on beneficiaries

The subproject is highly satisfactory and 89% of the beneficiaries answered that the water quality has been improved. 99% of them think that the improvement of water quality has had a good effect on their health. Many mentioned that the number of people suffering a calculus, a stomach disorder, or helicobacter pylori had decreased. On the other hand, some people pointed out problems concerning the management and maintenance of the water supply system, such as "Water is not supplied 24 hours

[26] The survey was carried out on 120 households in Santana City (including the villages of Pauzinhos and Cedro), which is covered by the subproject in Bahia State and 30 households in the city of Tabacos do Brejo Velho. Therefore, the number of samples is 150. Men and women accounted for 52% and 48%, respectively. By age group, 4% were in the age group of 19 and under, 14% in the age group of 20-29, 21% in the age group of 30-39, 18% in the age group of 40-49, 17% in the age group of 50-59, and 25% in the age group of 60 and over, 25%.

a day," "Because water contains much the residual chlorine, the quality as drinking water is lower than that of bottled water," and "problems, such as leakages, frequently occur." However, the access to water and the quality of water have been greatly improved compared to before. In the past, people had to go to wells or wait for water trucks, and some households could not use water for drinking because of the high salt concentration.

(2) Sergipe State

Before the implementation of the subproject, drinking water was distributed by water trucks every one or two weeks in nearly 40% of the target 25 cities. The water quality was often insanitary without disinfection, frequently causing diseases. The completion of the Semi-Arid water conveyance system made it possible to supply high-quality water purified from raw water in the Sanfrancisco River to each household 18 hours a day. Many people are satisfied with the subproject, and their living conditions have improved. Both states are positively giving environmental education to their residents, who are highly aware of the importance of water resources management and water supply systems. If people's awareness is high, their demand ordinarily grows. However, because the beneficiaries are highly satisfied, the subprojects can be evaluated as having some impact.

### 3.3.2 Other Impacts

(1) Impacts on the natural environment

No negative impact on the natural environment has been found. During the project, under the supervision of the states' water agencies, consultant companies appropriately managed the progress and monitored the environment. After the completion of the project, the water agencies carried out an environmental evaluation[27] and judged that the water infrastructure was constructed appropriately. The following are each state's environmental monitoring system and situation:

Bahia State: Water supply system control centers were established in Porte-Novo City and Santana City. The centers automatically detect the amount of water intake, the amount of water purification, and the remaining amount of each water supply tank and output data. Water quality monitoring data is sampled every two hours within each purification plant, and the transparency, residual chlorine content, and pH are recorded. Sampling inspections for colon bacilli in raw water are carried out twice a week. This data is provided to the Baleira branch of EMBASA in charge of the maintenance of the water supply system to be integrated with data from other water supply systems, and is submitted to the headquarters of EMBASA in Salvador City. The data is also submitted to the State's water resources agency, which inspects the quality of raw water and checks the impact on the Corriente River, which takes in raw water. Because the amount of water intake has been approved by the water resources agency and does not impose a heavy burden, no impact on the natural environment had been found by the time of the ex-post evaluation.

[27] Conducted in Bahia State in 2008 and in Sergipe State in 2011.

Sergipe State: The control center is located in Gloria City, the endpoint of the Semi-Arid water supply system. The center automatically detects amounts of water intake, amounts of water purification, remaining amounts of water supply tanks, etc., of the three water supply systems. The center gathers these data and submits them to the headquarters of DESO in Aracaju. The purification plant conducts the sampling of water every two hours and inspects and records the transparency, residual chlorine content, and colon bacilli and submits data to the headquarters of DESO. DESO writes this water quality data in the bills to disclose the information thoroughly. According to the Sergipe State water resources management plan, the permitted maximum amount of intake is 360 $m^3$ per second and the amount of intake was 335 $m^3$ per second (93% of the maximum amount) at the time of the ex-post evaluation. Because the amount is within the maximum amount set by the central government, it can be said that the environmental burden is within the scope of permission.

(2) Land Acquisition and Resettlement

Because most purification plants and control centers are located on the land owned by each state's public water corporation, the relocation of residents was unnecessary in both states. Although there were places where the installation of conduits required permission, compensation was properly paid and no problems occurred. Even in places where sites were acquired, no problems occurred with regard to the acquisition process, and there were no complaints from residents near the sites.

Table 11: Summary of Resident Relocation and Site Acquisition in the States of Bahia and Sergipe

| | Bahia | Sergipe |
|---|---|---|
| Relocation of residents | None | None |
| Affected households | None | None |
| Other compensation | None | None |
| Total value of acquired sites (R$) | 94,820 | 290,621 |
| Total value of acquired sites (¥million) | 4.7 | 14.5 |

Source: Compiled by the evaluators based on the questionnaire answers from the public water corporations in the States of Bahia and Sergipe
1 reais = 49.88 yen (average for 2004–2011; calculated based on the International Financial Statistics (IMF))

This project has largely achieved its objectives. Therefore, its effectiveness and impact is high.

## 3.4 Efficiency (Rating: ①)

### 3.4.1 Project Outputs

At the time of the appraisal, the States of Ceara, Bahia, and Sergipe were designated as candidates for yen loans, and the possibility of replacement was assumed.[28] In addition, there were no detailed contents of the subprojects, which were only outlined without any planned value for their scope. Therefore, herein it is impossible to do anything other than make a comparison between the plan at the time of the agreement on the detailed design and the actual results. The status of each subproject is as follows:

[28] Only an outline was given and it was assumed that a final decision would be made after conclusion of L/A.

Ceara State: At the time of the appraisal, purification plants were planned to be constructed to the west of Fortaleza City and in Caucaia City and the conduits with a total length of 34 km between Gavião reservoir, where the water would be taken in, and the purification plants were covered by the subproject. At the time of the agreement on the detailed design (2006), the construction of the purification plants was not included and the subproject was approved as strengthening the supply of drinking water to the western part of the Fortaleza metropolitan area and the supply of raw water to the Port of Pecem. However, as described above, bidding for construction was suspended,[29] and the loan disbursement period came at the end of September 2008. The Ceara State Government requested the Ministry of National Integration to expand the scope of the subproject and decided to carry out the subproject using a PAC loan, following the ministry's suggestion.[30] The subproject is in progress at the time of the ex-post evaluation.

Bahia State: Under the plan made when the detailed design was agreed (in 2003), all the components were expanded and approved as a water supply system for providing purified water to about 14,000 households (a population of 56,000 people) living in neighboring five cities, including Santana City,[31] and the surrounding villages. Table 12 shows the detailed specifications. The system was almost as planned, except for the water pipes and the water distribution network. The scale of the water distribution network became 166% of the planned scale for the following reasons: the coverage of the connected households was expanded from those in the target five cities to those in surrounding villages as well; the geographical undulations are great; length of pipe required became longer because it was necessary to make the pipes detour around highways in each city.

[29] Bidding procedures began in 2005 after an agreement was concluded to finance the subproject in the Ceara State at the end of 2004. However, the bidding was delayed for three months because several bidding companies filed a lawsuit for a review of the strict bidding qualifications. After that, the lawsuit was refused and bidding procedures reopened. Although a report on screening of qualifications was submitted to the state chief of justice in 2006, the public prosecutor office pointed out inconsistencies in the report and it took a half year to receive approval for the screening results. In June 2006, the results of the examination of the technical plan and qualification criteria were published. Because a bidding company filed a complaint, the bidding procedures were suspended again. In December 2006, the bidding procedures reopened and price screening was carried out for the two companies that passed the technical screening. Because both companies' bids were higher than the budget amount, adjustment was attempted many times in 2007. However, an agreement was not reached and the bidding was cancelled.

[30] It was decided that a yen loan should be applied to consulting service for detailed design.

[31] Canapolis City, Santana City, Serra Dourada City, Tabacos do Brejo Velho City, Brejolândia City

Table 12: Outputs of the Subproject in Bahia State

| Component | At the time of the appraisal (2003) | At the time of agreement on the detailed design (2003)[32] | Result (2008) | Difference * Note 1 |
|---|---|---|---|---|
| Amount of intake from the water source (1/s) | Not fixed | 160 | 160 | 100% |
| Purification plant (1/s) | 60 | 160 | 160 | 100% |
| All pump stations | 2 stations | 5 stations | 11 stations | 6 stations |
| Water pipes (km) | 36.0 | 144.0 | 161.9 | 112% |
| Water supply tanks | 2 tanks | 12 tanks | 10 tanks | --- |
| Water distribution network (km) | Not fixed | 85.0 | 140.9 | 166% |
| Houses connected to the water supply (no. of houses) | 3,900 | 7,000 | 8,353 | 119% |

Sources: JICA materials for appraisal; written agreement on the detailed design between the Ministry of National Integration and the Bahia State Government; final report on the subproject
Note 1: Difference between the plan at the time of the agreement on the detailed design between the Ministry of National Integration and the Bahia State Government and the results

Sergipe State: At the time of the agreement on the detailed design (in 2006), the establishment of the Semi-Arid water conveyance system and the repair of the Alto Sertão water conveyance system[33] and the Sertaneja water conveyance system[34] were approved as a subproject for strengthening the Sanfrancisco River's water intake and distribution capacity to supply water to about 200,000 people in 25 cities in Sergipe State. The Semi-Arid water conveyance system is 53 km in length, extending to Gloria City. For this system, a purification plan will be constructed in Porto da Folha, where the Alto Sertão water conveyance system exists. Because water distribution networks are not covered by the subproject, an existing water distribution network was used. With regard to the components about which the planned values were specified in the written agreement on the detailed design, the number of water supply tanks greatly increased, but the intake amount from the water source and the capacity of the purification plant were almost as planned (Table 13). Table 14 shows results of the repaired water conveyance systems.

[32] In 2003, an operation plan called the "Plan" was exchanged between the Ministry of National Integration's Water Infrastructure Agency, the federal government's PROAGUA unit, and the SEMARH, the state government's PROAGUA unit, and the subproject outline was agreed between them. In the next year, JICA also agreed on the same project outline.
[33] This is a water conveyance system that distributes water to the semi-arid zone in the northwestern part of Sergipe State. The purification plant is located on the premises where the purification plant for the Semi-Arid water supply system is located.
[34] This is a water conveyance system whereby water is taken in and purified in Amparo de Sanfrancisco to the south of the other two water conveyance systems' places of intake along the Sanfrancisco River and is distributed via Gloria City southward to Carira City, Pedra More City, Frei Paulo City, and Senhora das Dores City.

Table 13: Outputs of the Subproject in Sergipe State (Semi-Arid Water Conveyance System)

| Newly established components | At the time of the appraisal (2003) | At the time of agreement on the detailed design (2006)[35] | Result (2011) | Difference * Note 1 |
|---|---|---|---|---|
| Amount of intake from the water source (1/s) | Not fixed | 270 | 317 | 117% |
| Purification plant (1/s) | 650 | 270 | 280 | 104% |
| All pump stations (1/s) | Not fixed | Not fixed | 935 | --- |
| Water pipe (km) | 43.0 | Not fixed | 53.5 | --- |
| Water supply tanks ($m^3$) | Not fixed | 1,000 | 2,500 | 250% |
| Water distribution network (km) | --- | --- | --- | --- |
| Houses connected to the water supply (no. of houses) | --- | --- | --- | --- |

Sources: JICA materials for appraisal; written agreement on the detailed design between the Ministry of National Integration and the Sergipe State Government; final report on the subproject
Note 1: Difference between the plan at the time of the agreement on the detailed design between the Ministry of National Integration and the Sergipe State Government and the results

Table 14: Outputs at the Time of the Repair of the (Existing) Water Conveyance Systems * Note 1

| Repaired components | Alto Sertão water conveyance system | Sertaneja water conveyance system | |
|---|---|---|---|
| Amount of intake from water source (1/s) | 280 | 280 | In this project, the existing water conveyance systems were repaired, mainly by strengthening the electric power systems, replacement of the pump motors and pipes, repair of the water tanks (such as measures against leakage), and the installation of equipment for the automation of the water conveyance systems. A water conveyance system consists of 54 components. |
| Purification plant (1/s) | 270 | 270 | |
| All pump stations (1/s) | 33 | 603 | |
| Water pipe (km) | 238.5 | 321.6 | |
| Water supply tanks ($m^3$) | 17,080 | 2,800 | |
| Water distribution network (km) | --- | --- | |
| Houses connected to water pipes (no. of houses) | 6,000 | | |

Source: Final report on the subproject
Note 1: Nothing has been written in JICA materials for the appraisal. No planned value has been written in the written agreement on the detailed design.

### 3.4.2 Project Inputs

#### 3.4.2.1 Project Cost

As described above, at the time of the appraisal, three subprojects were designated as candidates for yen loans, and the possibility of replacement was allowed. Because of this, it was only decided that, of the total project cost (planned) of 6,308 million yen (3,595 million yen in foreign currency, 2,713 million yen in domestic currency), yen loans of up to 3,595 million yen should be provided. The actual total project cost was 6,612 million yen (3,486 million yen in foreign currency, 3,126 million yen in

[35] In 2006, with regard to the project outline, a written agreement entitled "Convenio e Sertaneja" was concluded between the Ministry of National Integration's Water Infrastructure Agency, the federal government's PROAGUA unit, and SEMARH, the state government's PROAGUA unit. In the following year, JICA also agreed on the same project outline.

domestic currency; 105% of the planned cost), which was higher than planned.[36] About 30% of the total project cost was used for Bahia State, about 70% was used for Sergipe State, and less than 1%[37] was used for Ceara State, to which PAC loans were applied. If the cost is compared with the project cost at the time of the agreement on the subproject, the actual project cost was 110% higher than planned in Bahia State and 50% higher than planned in Sergipe State. In Bahia State, as a result of consideration of the increase in the population in the future, the necessary number of pump stations was doubled, the necessary size of the water distribution networks increased by 60%, and the number of water supply households increased by 20%. Moreover, because the work period was prolonged, the consulting services costs increased by 130%. In Sergipe State, the greatest factor was the delay in the work period. Concretely, it took some time to carry out the preliminary survey for the repair of the water supply system and to identify specifications; it took more than two years to procure the various materials and equipment; and it took some time to change important parts of problematic water pipes made of rigid polyvinyl chloride (hereinafter referred to as "RPVC")[38].

#### 3.4.2.2 Project Period

Although the project period was scheduled from April 2003 to March 2006 (36 months) at the time of the appraisal, it was actually from April 2003 to November 2011 (104 months; 289% of the planned period), except for Ceara State, where the subproject has still not been completed. The actual subproject period was significantly longer than planned. It increased by 81% to 65 months in Bahia State and increased by 189% to 104 months in the Sergipe State.

The subproject period was longer than planned in each state because the project management took much time, including subproject approval and bidding procedures. Although it was estimated that bidding would take six months, it actually took one year for public works, two years for consulting services, and two years for the procurement of equipment.[39] With regard to public works and consulting services, it took much time to deal with the unsuccessful lawsuits of the bidders concerning the bidding qualifications and technical examinations and hold contract negotiations. With regard to the procurement of equipment and materials, it took much time to examine the estimates of several bidders and proceed with competitive bidding. In Sergipe State, the construction itself was delayed because, in addition to the above-described problems in the quality of materials for the RPVC water pipes, the water supply system in use could not be moved and it took much time to construct a new

[36] Because the project cost was not estimated based on a specified scope of outputs at the time of the appraisal, it was impossible to judge the appropriateness of the expansion of the project cost as a result of the change in the scope.
[37] 23 million yen for consulting services related to the detailed design
[38] Because RPVC is inexpensive, light, and so mechanically workable that it is easy to cut it and make holes in it, it is used as a constructional material for water pipes and rainwater pipes. On the other hand, it is hard, easily breakable, and cannot be used at a temperature higher than about 80 degrees centigrade. Although it was often used as a material for water conveyance and distribution pipes for the water supply systems under the subprojects (in Bahia State and Sergipe State), deformation, breakage, and other trouble frequently occurred at the connection parts where the water pressure caused frictional heat.
[39] In Bahia State, it took six months to receive approval for the subproject, 26 months to select the consultants, and nearly 21 months to select the constructors. It took three years to determine the scope, coordinate the credit lines among the subprojects, file various applications up to the national auditing agency's approval, and carry out bidding/contracting procedures. In Sergipe State, it took 40 months to receive approval for the subproject and select the consultant companies and 25 months to select the constructors and materials/equipment suppliers.

building to introduce new equipment. Moreover, because the electric power distribution equipment was too old to install the water supply system, it took much time to analyze and verify compatibility with the new equipment.

### 3.4.3 Result of Calculation of Internal Rate of Return (Reference only)

At the time of the appraisal, the following were assumed: the project life would be 20 years; the benefit would be the revenues from charges that can cover the total maintenance costs; and the costs would be the construction expenses and management and maintenance expenses.[40] With regard to the subproject in Bahia State, the Financial Internal Rate of Return (FIRR) became minus when it was calculated on the following assumption: the project life would be 20 years; the benefit would be the revenues from water supply; and the costs would be the operating expenses, management and maintenance expenses, and taxes. Because water supply service is highly public, the profitability is low. In addition, the project costs more than doubled because the water supply area became larger than planned, the scope was expanded, and the construction was delayed. In Sergipe State, because it is unknown by how much the benefit of the repair increased, the FIRR could not be calculated.

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

## 3.5 Sustainability (Rating: ③)

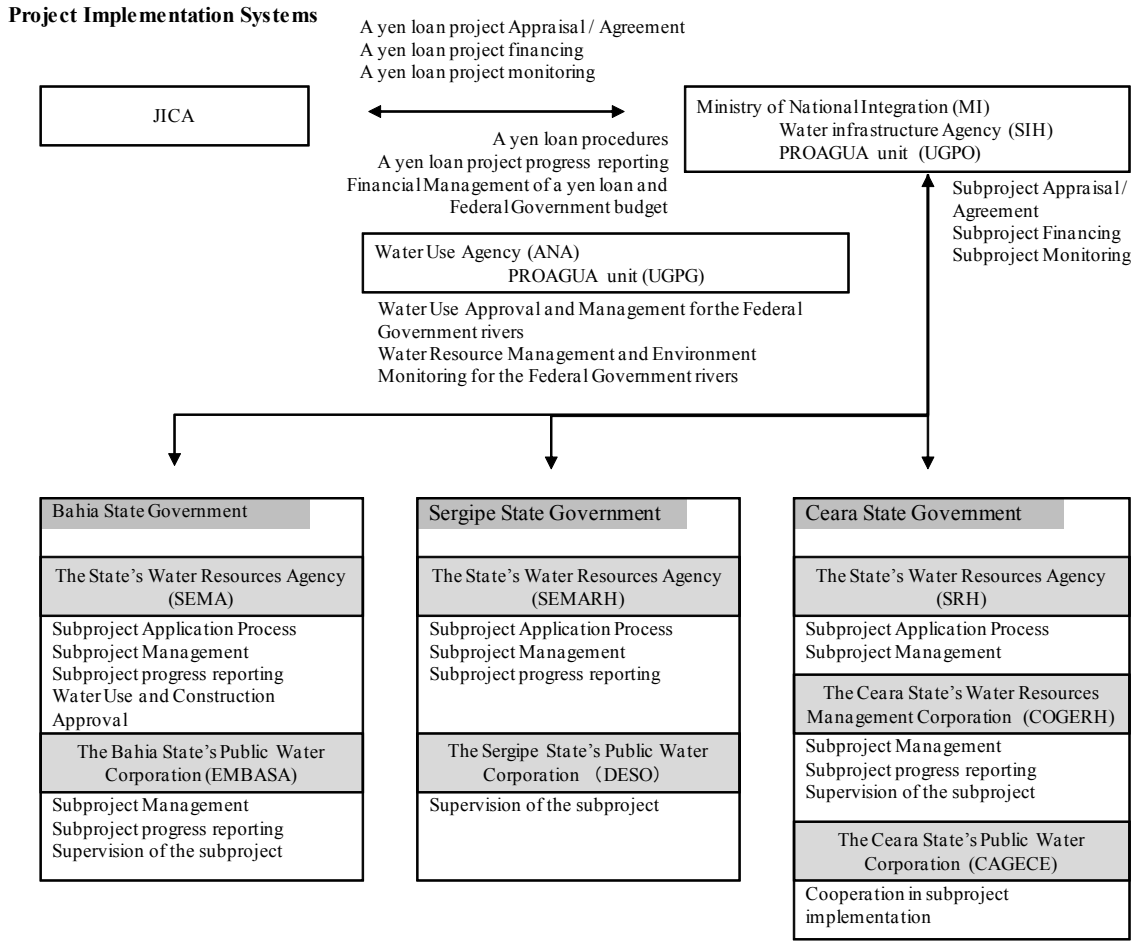
The implementing agencies of this project were the PROAGUA unit of the Ministry of National Integration's water infrastructure agency (hereinafter referred to as "UGPO"), which supervised the subprojects, and the water use agency's PROAGUA unit (hereinafter referred to as "UGPG"). UGPO is an organization in charge of water projects throughout Brazil, while UGPG is an organization that, from the viewpoint of water resources management and environmental considerations, examines and approves subprojects submitted by state governments. As a state coordinating agency, a POAGUA unit that supervised and monitored the subproject had been established in each state's water resources and environment bureau. The implementation, management, and maintenance of the subprojects were directly controlled or entrusted to the state water corporations. Figure 8 shows the implementation system.

In the same way as under other PROAGUA programs, all the facilities were handed over to each state water supply corporations after the completion of the project. Each state's water supply corporation has the authority and responsibility for the management and maintenance of all the installed facilities. Each state government's PROAGUA unit also ceased to play its role, and the state government's water resources management agency is playing the role of monitoring the environment and giving guidance on management to the state water supply corporation.

Under the PROAGUA implementation system above, the supervision of the implementation of the project by the Ministry of National Integration was inadequate. The Ministry neither fully monitored

[40] No FIRR value has been written in JICA materials for appraisal.

the project nor correctly assessed the date of completion of the project or the condition of the facilities. As a result, it became clear through the ex-post evaluation that the Ministry did not fully share information with JICA. The Ministry, the implementation agency, does not supervise or monitor state water supply corporations in charge of management and maintenance through each state's water resources management agency after the completion of the project. Because it is necessary for the Brazilian government to monitor a yen-loan project regularly until completion, submit the project completion report, and provide information afterwards if necessary, it was essential for the government to establish a system for such purposes.

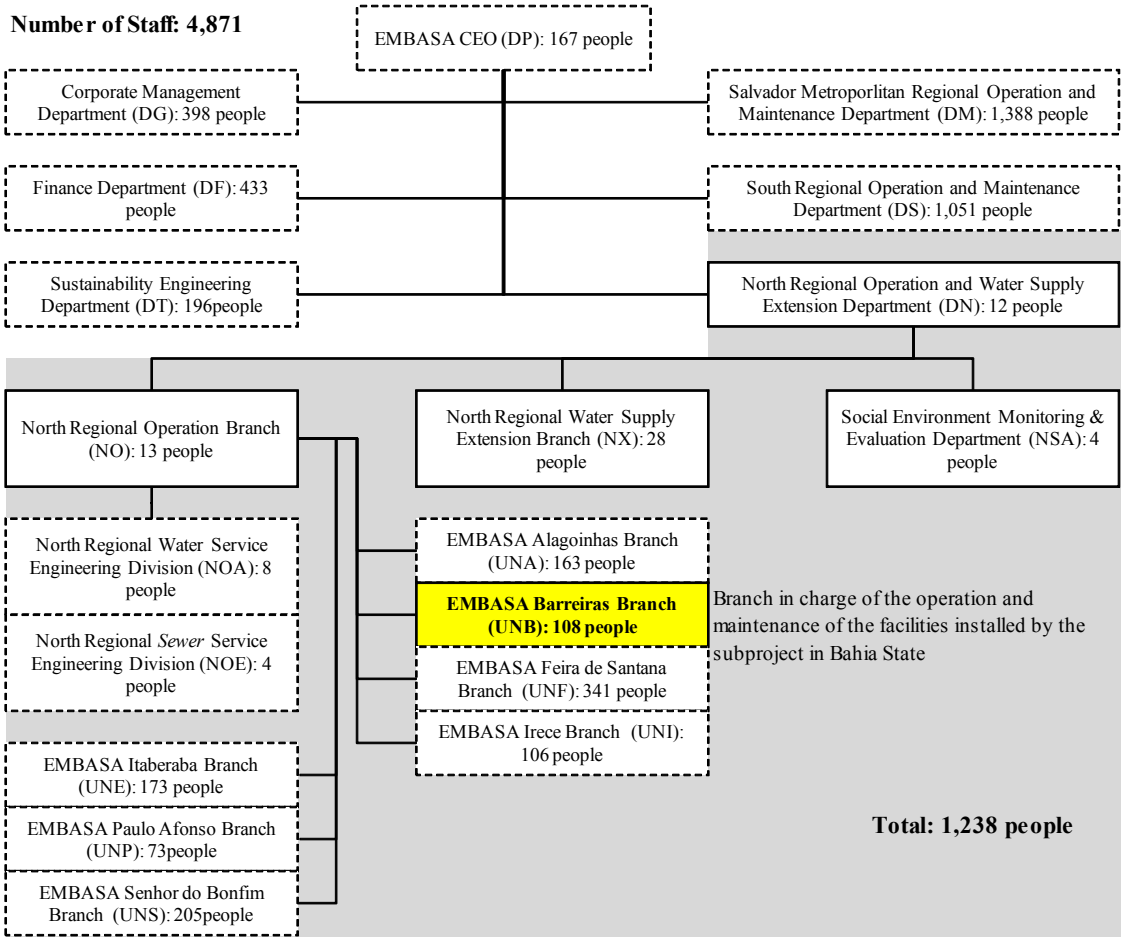



Source: Created by the Evaluators through interviews with the Ministry of National Integration

Figure 8: The Federal and State Governments' Project Implementation Systems

### 3.5.1 Institutional Aspects of Operation and Maintenance

Bahia State: The managing and maintaining agency is EMBASA. The following figure shows the organizational structure of EMBASA:



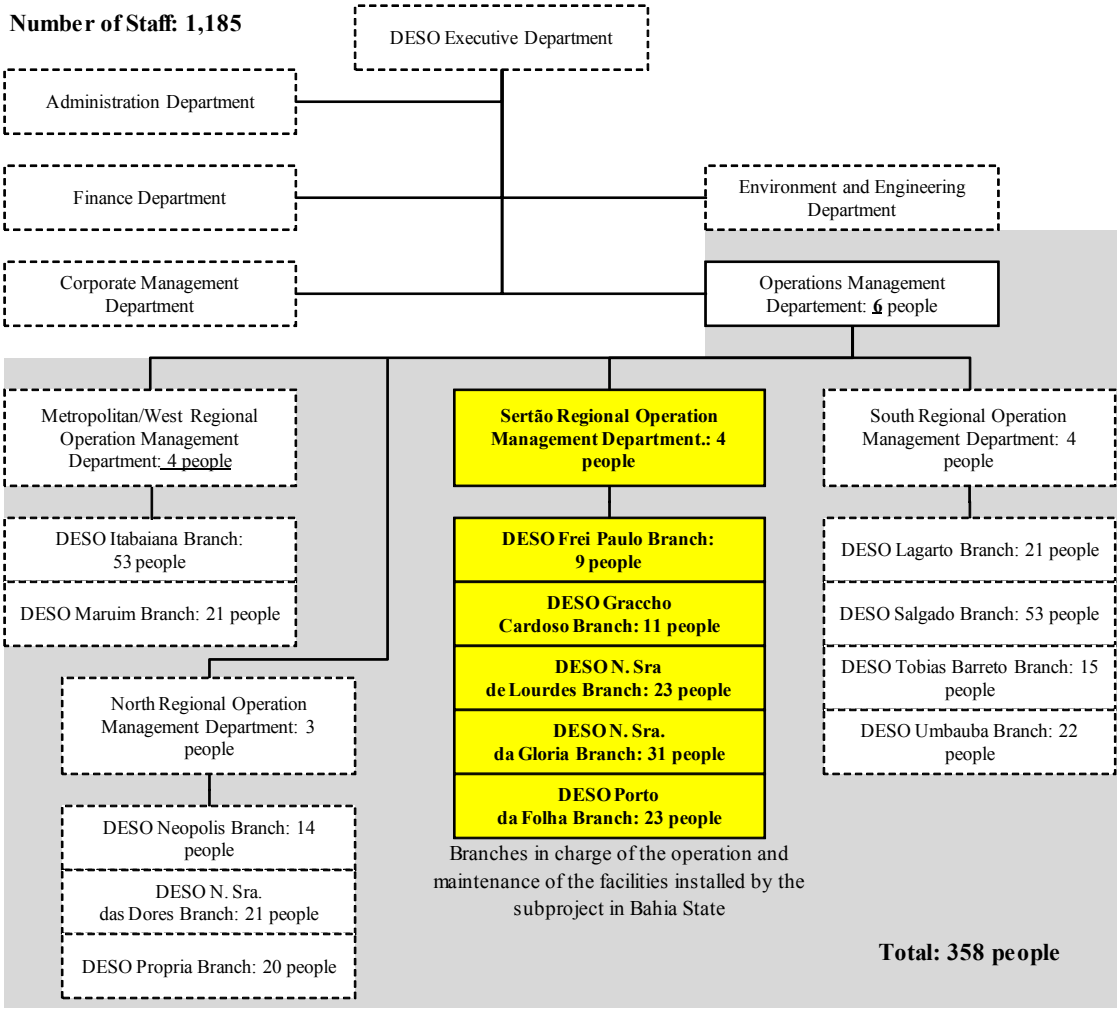

Source: Organization chart (2014) provided by the Public Water Corporation in Bahia State (EMBASA)

Figure 9: Organizational Structure of the Public Water Corporation in Bahia State (EMBASA)

As of 2010, EMBASA supplies water to 360 cities among the 415 cities in Bahia State and covers 88% of the water supply population in the state (about 10,220,000 people). The water supply system established under the subproject has been managed by the Barreiras branch under the North Operation Management Department and a half of the total staff of 108 people are in charge of the management and maintenance of the system.[41] This system is adequate to maintain the water supply system, and human resources have been efficiently assigned through automation of the coordination of water distribution.

Sergipe State: DESO manages and maintains the water supply facilities. The following is the organizational structure of DESO.

[41] Engineers (senior engineers and technical engineers) account for about 10% of the total staff of EMBASA.




Source: Organization chart (2014) provided by the Public Water Corporation in Sergipe State (DESO)

Figure 10: Organizational Structure of the Public Water Corporation in Sergipe State (DESO)

As of 2010, DESO supplies water to 73 cities out of the 75 cities in Sergipe State. It covers 94% of the water supply population in Sergipe State (About 1,680,000). The water supply system established under its jurisdiction is maintained by 101 staff members of five branches under the Sertão Regional Operation Management Department.[42] It has sufficient human resources to manage and maintain the water supply system. Like EMBASA, DESO has automated the adjustment of water distribution to improve efficiency. All the agencies in charge of maintenance during and after the project have been designated by law, and their roles and powers have been specified. Because systems to meet demand for water supply in the future have been established, there is no problem in the implementation systems in Bahia State and Sergipe State.

[42] Engineers (senior engineers, chemical engineers, and technical engineers) account for about 9% of the total personnel of DESO.

### 3.5.2 Technical Aspects of Operation and Maintenance

In both Bahia State and Sergipe State, troubles occurred at the time of the test operations, such as leakage from water pipes and a burst in a pipe section connected to a pump motor due to water pressure. Since full-scale operation, no problems that hinder the operation of the water supply systems have occurred concerning management and maintenance. As both states have managed and maintained the water supply systems smoothly, no technical problems have occurred. The systems have regularly been maintained and inspected according to the manual prepared by the consultant in charge of the supervision and monitoring of the constructors and their work.

Bahia State: As there are human resources with the techniques required for the management and maintenance of the automatic water supply systems and the detection of leakages, no technical problems have occurred. According to the results of the interview survey, because EMBASA has employed many new staff members in recent years, not only training to have all personnel acquire the latest techniques, but also technical training for new staff members have become more necessary year by year. From 2009 to 2013, EMBASA held training sessions on maintenance, environmental education, and public health improvement several times a year and positively provided on-the-job training.

Sergipe State: According to the results of the interview survey, there were no special problems concerning the number and quality of the staff at the time of the ex-post evaluation. However, , there is an imminent need to employ human resources for maintenance and more technical engineers because a new water supply system is planned to be operated from the starting points of three water pipes. Taking this situation into consideration, DESO plans to employ chemical engineers specialized in the analysis, measurement, and examination of water quality and engineers who can manage and maintain an automatic water supply system. In 2005, it newly employed 304 staff members who had passed technical civil servant examinations. Since then, it has provided full technical training to them. It has regularly held maintenance training since 2009.

As a result, there are no technical problems in either Bahia State or Sergipe State.

### 3.5.3 Financial Aspects of Operation and Maintenance

At the time of the appraisal, it was judged that sufficient budget measures could be taken concerning this project because the financial conditions were sound in the States of Bahia, Ceara, and Sergipe, and there was no budget problem concerning the subprojects financed by the World Bank. At the time of the ex-post evaluation, it was confirmed that the financial conditions of the public water corporations of both states are sound enough to pay the management and maintenance expenses of the water supply systems. Because both states have legally specified methods for setting water rates, their water rates cannot be changed without permission from the state certification organizations. It is fair to say that this system is reasonable.

Bahia State: EMBASA's service areas include large cities such as Salvador. Revenues from these large cities are used for the maintenance of water supply systems in rural areas where the number of households is low. As shown in Table 15, the ratio of management and maintenance expenses to EMBASA's total revenues has been stable at about 60%. EMBASA's current ratio was 128% in 2010, 119% in 2011, and 132% in 2013. The capital adequacy ratio was 75%, 73%, and 73% in the respective years. The ratio of fixed assets to long term capital was less than 100% in all those years.

Therefore, EMBASA has no problem in its ability to pay, its financial condition is highly stable, and its financial sustainability is high.

Table 15: Revenues and Management and Maintenance Expenses of the Whole EMBASA in the Bahia State

(Unit: million yen)

| Year | Water supply service revenue | Sewerage service revenue | Other revenues | Total | Management/ maintenance expenses | Ratio of management/ maintenance expenses to revenues |
|---|---|---|---|---|---|---|
| 2009 | 48,365 | 12,814 | 1,686 | 62,866 | 38,782 | 61.7% |
| 2010 | 55,569 | 15,147 | 1,706 | 72,422 | 43,438 | 60.0% |
| 2011 | 64,309 | 17,267 | 1,558 | 83,134 | 49,903 | 60.0% |
| 2012 | 72,925 | 20,212 | 1,963 | 95,100 | 57,860 | 60.8% |
| 2013 | 78,781 | 23,309 | 1,736 | 103,826 | 62,037 | 59.8% |

Source: Calculated by the evaluators based on questionnaire answers from EMBASA
Note: 1 reais = 49.88 yen

Sergipe State: The subproject area consists of 25 cities, which account for 34% of DESO's water supply areas. It is a semi-arid area where water demand is high. The revenues from water supply in the area sharply increased in 2011, when the subproject was completed, and became five times as much as those in 2010. The revenues are sufficient to cover the management and maintenance expenses for the water supply system. As shown in Table 16, most of the revenues have been used for the operation and maintenance expenses in the whole service area of DESO. On the other hand, the Ministry of National Integration provides subsidies to the Sergipe State Government every year when the Sergipe State Government makes an application for its development plan, because the development of waterworks is one of the important national projects for the establishment of infrastructure. Some of the subsidies are provided to DESO for infrastructure development and are used for necessary investments. With regard to DESO's financial indicators, the capital adequacy ratio is very high at 80% to 81%, indicating that its funds are highly stable. The current ratio was 65% in 2010, 77% in 2011, and 104% in 2013, indicating that the ability to pay has improved year by year.

Table 16: Revenues and Management and Maintenance Expenses for the Whole of DESO in Sergipe State

(Unit: million yen)

| Year | Water supply service revenue | Sewerage service revenue | Other revenues | Total | Management/ maintenance expenses | Ratio of management/ maintenance expenses to revenues |
|---|---|---|---|---|---|---|
| 2009 | 11,005 | 1,495 | 492 | 12,992 | 12,443 | 95.8% |
| 2010 | 12,251 | 1,677 | 71 | 13,998 | 14,278 | 102.0% |
| 2011 | 13,297 | 1,894 | 71 | 15,262 | 15,644 | 102.5% |
| 2012 | 15,561 | 2,174 | 80 | 17,815 | 16,592 | 93.1% |
| 2013 | 16,463 | 2,287 | 136 | 18,886 | 18,375 | 97.3% |

Source: Calculated by the evaluators based on questionnaire answers from DESO
Note: 1 reais = 49.88 yen

In this way, there is no financial problem with regard to the subprojects in Bahia State and Sergipe State.

### 3.5.4 Current Status of Operation and Maintenance

During this ex-post evaluation, the status of operation of the water supply systems in both states was studied. It was found that some parts of the water supply systems were damaged. Those damaged parts include panels installed in pump stations and purification plants to display the water flow rate, and sensors that automatically detect the quantity of water in the water storage or supply tanks. It takes two to three months to repair them, because these parts can be procured only from the São Paulo State or other distant places. However, such trouble did not hinder the operation of the water supply systems, and no great problem was found in the records of purification treatment and water distribution Therefore, it can be judged that the status of operation and maintenance of the water supply systems established under this project is good in general. Expendable supplies, such as chemicals for purification treatment are well-stocked, and there is no special problem regarding other spare parts since most of them can be procured within the state.

Bahia State: The study found leakage from a water pipe of the water supply system in the suburbs of Santana City. Although the leakage does not hinder the operation of the system, the pipe will be replaced as soon as a budget is secured. Table 18 shows the status of operation and maintenance of the main equipment.

Table 18: Status of Operation and Maintenance of the Water Supply System in Bahia State

| Equipment | Condition | Study results |
|---|---|---|
| Intake facilities | 2 | Slight leakage was found from a tank that temporarily stores water after intake. Although it is unnecessary to deal with it immediately, it is planned that measures will be taken soon. |
| Purification plants | 1 | All the purification processes were operating without any problem. Polluted mud is dehydrated on a sun drying floor and disposed of as waste. How to use it effectively is under consideration. |
| Water conveyance / distribution pipes | 3 | After the start of operations, it was found that there was leakage along a length of 42 km from a water pipe made of RPVC. Accordingly, pipes at the connections, where the water pressure is high, were replaced by the state's own funds. It is planned that the pipes at places where leakage is heavy will be replaced. No leakage has hindered the operations. |
| Pump stations | 2 | In some pump stations, panels displaying outputs and the capacity to convey water were under repair. Some damaged panels were left as they were for several months. |
| Water storage tanks | 2 | Some water storage tanks were not automatically checked at the Porto-Novo purification plant and the Santana City control center, because automatic sensors for measuring the volume of remaining water were out of order,. Although there is no problem in the water supply, it is planned that measures will be taken soon. |

Source: Compiled by the evaluators based on the results of the field inspection
Remarks: 1. No problem; 2. No special problem; 3. Room for improvement; 4. Immediate measures are necessary because of operational trouble

Bahia State plans to expand the water supply systems according to the increase in the population in the target areas so that water supply can be continued in the target five cities and surrounding villages.

Under this subproject, the water supply system was automated[43] for the first time in the state. Bahia State is planning to establish similar water supply systems in other areas based on the knowledge and experience gained through the subproject.

Sergipe State: After the water supply systems began to operate in Bahia State, many leakages occurred. Subsequently, leakages from water pipes made of RPVC frequently occurred during the subproject in Sergipe State. The state government verified the methods for solving the problem and replaced water conveyance and distribution pipes. By the time of the ex-post evaluation, the leakage problem had almost been solved. Although the repair of existing water conveyance pipes required the replacement of existing pump motors with higher-performance ones, some problems occurred. For example, the existing electric power infrastructure was too old to carry out the replacement of this infrastructure. However, these technical problems were completely solved, and the water supply systems established under this subproject were operating without any problem.

Table 19: Status of Operation and Maintenance of Water Supply Systems in Sergipe State

| Equipment | Condition | Study result |
|---|---|---|
| Intake facilities | 1 | There is no special problem. |
| Purification plants | 2 | The treatment of polluted mud was unnecessary and only filtering and residual chlorine treatments were carried out, because the water quality in the Sanfrancisco River is very high. It is necessary to consider how to deal with cases where the treatment of polluted mud becomes necessary due to deterioration of the quality of the water from the river. |
| Water conveyance / distribution pipes | 1 | There is no special problem. |
| Pump stations | 2 | In some pump stations, panels displaying outputs and the ability to convey water were under repair. Some measures are necessary for effective operation and maintenance. |
| Water storage tank | 1 | There is no special problem. |

Source: Compiled by the evaluators based on the results of the field inspection
Remarks: 1. No problem; 2. No special problem; 3. Room for improvement; 4. Immediate measures are necessary because of operational trouble

No major problems have been observed in the institutional, technical and financial aspects of the operation and maintenance system. Therefore, sustainability of the project effect is high.

## 4. Conclusion, Lessons Learned and Recommendations

### 4.1 Conclusion

The northeast region is characterized by a hot and dry climate and is known as the driest region in Brazil. This project aims to supply safe drinking water to local people stably by constructing water supply facilities in the region. Its relevance is high because the aim is consistent with the Brazilian Government's policies and development needs and Japan's aid policy. Of the three states where

[43] At the time of the ex-post evaluation, it had been planned that automation will be limited to the water flow rate, volume of purification, and pressure. However, automatic water quality surveys are under contemplation.

subprojects were supposed to be carried out under this project, the water supply population has steadily grown to 50,000 in Bahia State and 200,000 in Sergipe State. The exception is Ceara State, which eventually received loans under the Growth Acceleration Program. According to the results of a survey on beneficiaries in Bahia State, many people's health condition improved because of the improvements in water quality, and the subproject is highly satisfactory. In Sergipe State, the subproject has promoted the supply of water to 25 cities among the 75 cities in the state, and the effect of the subproject extends widely, such as planning the distribution of water to basins along the Sergipe River where demand for water supply is the highest. In this way, this project is contributing significantly to water supply in this dry region, and the effectiveness and the impact are high. With regard to efficiency, it took much time to receive approval for the subprojects, and the construction period was prolonged because of an expansion of the scope, with the result that the project duration and cost greatly exceeded the estimates. After the completion of the project, the facilities were transferred to public water utilities in each of the states, and no problem has occurred in the systems and technologies of the utilities in charge of the management and maintenance of the facilities. The financial conditions are good, because the profitability of all the implementing agencies in Bahia State is high and Sergipe State has been subsidized. Therefore, the sustainability of the effects that emerged owing to this project is high.

In light of the above, this project is evaluated to be satisfactory.

## 4.2 Recommendations

### 4.2.1 Recommendations to the Executing Agency

After the completion of this project, the executing agency delegated the responsibility for the operation and maintenance of all the facilities established under this project to each state's public water corporation and did not carry out monitoring as the executing agency of a yen-loan project afterwards. It is very important for the executing agency to fulfill its accountability for the loans toward the people of Brazil because the loans are provided from borrowing and national taxes. As the improvement of the water distribution networks has been planned in order to supply water to more households, it is essential to monitor and evaluate the operation and effect indicators for the water supply facilities after the completion of this project. Although PROAGUA has not specified the Ministry of National Integration's monitoring system after the completion, it is desirable to establish monitoring and evaluation systems to fulfill accountability to the Brazilian people and use them for the plan to extend water distribution networks. It is also necessary to evaluate after its completion the subproject in Ceara State, to which PAC loans were applied.

### 4.2.2 Recommendations to the Bahia State Implementation Agency

It was confirmed through the beneficiary survey in Bahia State that drinking water was improved to some extent by the subproject. The survey also made it clear that many residents want the state

government to strengthen measures against leakage. Because leakage has frequently occurred at key water conveyance parts made of RPVC, water pipes for those parts have been replaced one after another. It is desirable to strengthen the measures and improve the level of satisfaction of the residents. With regard to the water supply hours, nearly half of the residents think that water should be supplied 24 hours a day. This is because there are areas where, for the difference in height of the land, the water remaining in the water supply tanks is also supplied for the remaining three hours after the 21-hour operation of the water supply pumps. As a result, it is inevitable that many residents have a sense of unfairness. Many residents are also not satisfied with the water supply because they do not understand the purpose of the current 21-hour water supply, which is to reduce the water supply costs by suspending the operation of water supply pumps from 19:00 to 22:00, when electricity rates become higher. Enhancing dissemination of information on the status of operation of the water supply and the reasons would be helpful in facilitating the understanding of the residents.

#### 4.2.3 Recommendations to the Sergipe State Implementation Agency

In Sergipe State, the installation of conduits and water pipes and the automation of water supply systems through the use of four basins in the state, including the Sanfrancisco River basin, have been promoted and the water distribution network that uses these water supply systems has been expanding throughout the state. As a result, it is immediately necessary to increase the number of engineers in charge of the operation of the water supply systems. As of the time of the ex-post evaluation, although engineers were employed for a short period or operations were outsourced, no full-time engineers have been employed since 2005. Because the DESO personnel are aging, DESO is expected to employ full-time workers from the long-term perspective.

#### 4.2.4 Recommendations to JICA

None.

### 4.3 Lessons Learned

**(1) Strengthening the implementation and supervision system**

It was decided that, during this project, the Ministry of National Integration's infrastructure agency would be in charge of coordination with JICA under the implementation system of PROAGUA. However, the agency's implementation system was weak because of a lack of staff and lack of budget, and the agency also served as the coordinator for other loan projects, resulting in a work overload. As a result, the implementation and supervision of the project was insufficient, and the handling of problems tended to be delayed. If implementation and supervision had been carried out sufficiently, the agency could have recognized the problem of leakage from water pipes made of rigid polyvinyl chloride (RPVC), which occurred at the beginning of 2009 just after the start of operations in Bahia State, and shared their knowledge of the problem with Sergipe State. Because this project was carried

out under PROAGUA's implementation system, it seemed practically impossible for JICA to have its own implementation system. However, if such a project consisting of subprojects is carried out, it is necessary to establish the implementation and supervision system by such means as speeding up the yen-loan project and promoting capacity building in coordination with incidental projects and other schemes so that securing the staff and strengthening of the organization can be carried out smoothly.

**(2) Grasping the implementation status and effects of the project through operational and effect indicators**

At the time of the appraisal, this project had neither confirmed subprojects nor operational and effect indicators. The project plan was set after subprojects were confirmed. However, in this ex-post evaluation, it was not possible to assess the situation at the time of project planning, obtain materials that could serve as grounds for the assumed operation and effect indicators, and confirm whether such operational and effect indicators were set. The progress report prepared by the executing agency mentioned the specifications of the facilities, progress of the work, and the cost and period of each component, but it did not refer to any prospects on operation and effect indicators. Thus its contents were insufficient for the monitoring on the project's effects. To avoid such a situation, it is very important during the implementation of a project to grasp its progress and effects by such means as operational and effect indicators that are agreed upon at the time of project planning. If, at the planning stage, the system and capacity of the executing agency to set operational and effect indicators seems insufficient, it is worth considering the inclusion of the following in the consulting services: creation of a system for regularly monitoring the operation and effect indicators; capacity building for this purpose; and the submission of the monitoring results during the consulting service period.

**(3) Necessity for preliminary testing of the durability of piping materials**

For the subproject in Bahia State and Sergipe State, rigid polyvinyl chloride (RPVC) was used as material for the water pipes around 2006, when the installation began, because it was inexpensive and light in weight. However, because it is not resistant to heat, it is not suitable as a material for pipes used in parts that can be deformed or expanded by high temperatures, such as the connecting parts that are under high water pressure. In Sergipe State, this problem was discovered just after the installation. The pipes in the problematic parts were replaced, resulting in an increase in the project costs. In Bahia State, many leakages were found in key sections of the water pipes after the completion of the project. The replacement of the pipes was in progress at the time of the ex-post evaluation. To avoid such a situation, it is necessary to apply appropriate design standards so that water pipe materials with the specifications that can withstand respective external environmental conditions are chosen through the following steps: verify at first the specifications and durability of materials for the water pipes at the preparatory survey stage; and then examine the materials more thoroughly at the detailed planning stage.

End.

**Comparison of the Original and Actual Scope of the Project**

| Item | Plan | Results |
|---|---|---|
| 1. Outputs<br>Bahia State | Intake (not determined);<br>purification plant 60 l/s;<br>2 pump stations;<br>water conveyance pipes 36 km;<br>2 water supply tanks;<br>water distribution network (not determined);<br>3,900 households connected to water supply | Intake 160 l/s;<br>purification plant 160 l/s;<br>2 pump station 478 l/s;<br>water conveyance pipes 161.9 km;<br>10 water supply tanks;<br>water distribution network 140.9 km;<br><br>8,353 households connected to water supply |
| Sergipe State | Intake (not determined);<br>purification plant 650 l/s;<br>pump station (not determined);<br>water conveyance pipes 43 km;<br>water supply tank (not determined) | Intake 317 l/s;<br>purification plant 280 l/s;<br>pump station 935 l/s;<br>water conveyance pipes 53.5 km;<br>water supply tank 2,500 l/s |
| Ceara State | Intake (not determined);<br>purification plant 3,500 l/s;<br>pump station (not determined);<br>conduits 34 km;<br>water supply tank (not determined);<br>water distribution network (not determined);<br>water supply connected to households (not determined) | Changed to another loan |
| 2. Period | April 2003 – March 2006<br>(36 months) | April 2003 – November 2011<br>(104 months) |
| 3. Project cost<br>Foreign currency<br>Domestic currency<br><br>Total<br>Yen loan<br>Exchange rate | ¥3,595 million<br>¥2,713 million<br>(40.85 million reais)<br>¥6,308 million<br>¥3,595 million<br>1 R$ = ¥66.4<br>(As of April 2003) | ¥3,486 million<br>¥3,126 million<br>(62.67 million reais)<br>¥6,612 million<br>¥3,486 million<br>1 R$ = ¥49.88<br>(Average between 2004 and 2011)<br>Source: International Financial Statistics (IMF) |

Note: (Not determined) in the output plan means that no target was set.