

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 resources¹ 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 state²), 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% Interest rate for consulting services: 1.8% Repayment Period: 25 year (Grace Period: 7 years) 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	<ul style="list-style-type: none"> • Project for the Management of Non-Revenue Water, technical cooperation (2007–2010) • Non-Revenue Water Control Project in Sao Paulo State, yen-loan project (L/A 2012) • 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: B⁴)

3.1 Relevance (Rating: ③⁵)

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 programs⁷ 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

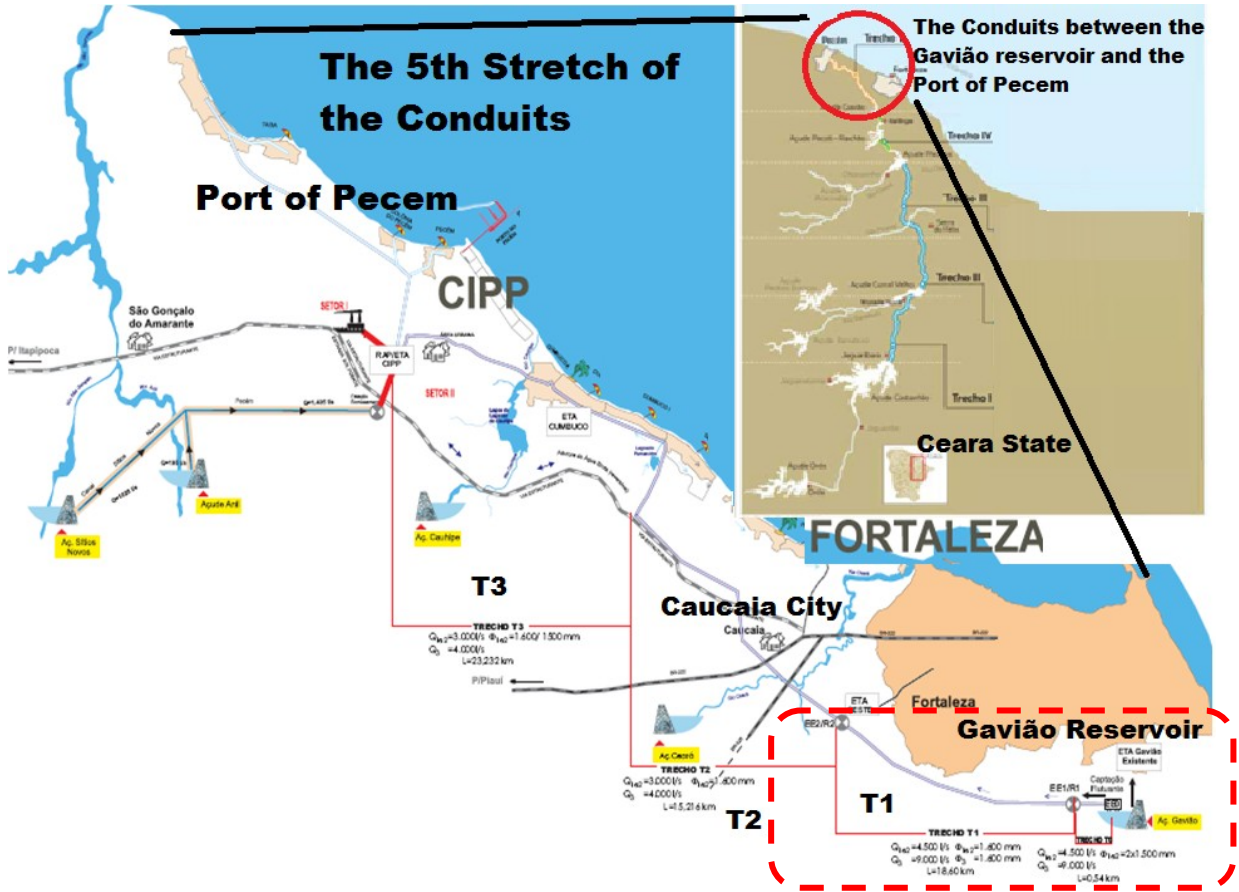
⁴ A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory

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 Fortaleza⁸ 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.

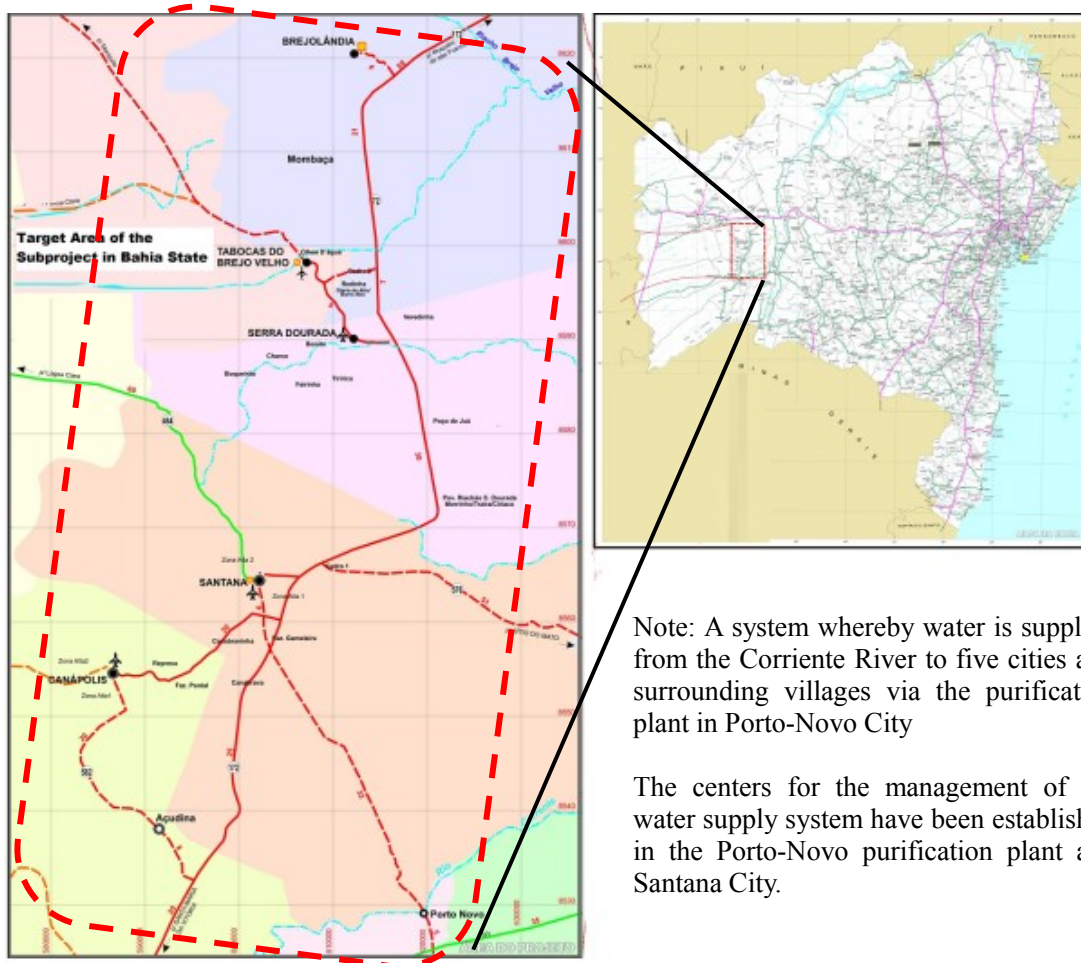


Source: Detailed design document for the Conduit Installation Project between Gavião reservoir and the Port of Pecem

Figure 1: Target Area of the Subproject in Ceará 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.



Note: A system whereby water is supplied from the Corriente River to five cities and surrounding villages via the purification plant in Porto-Novo City

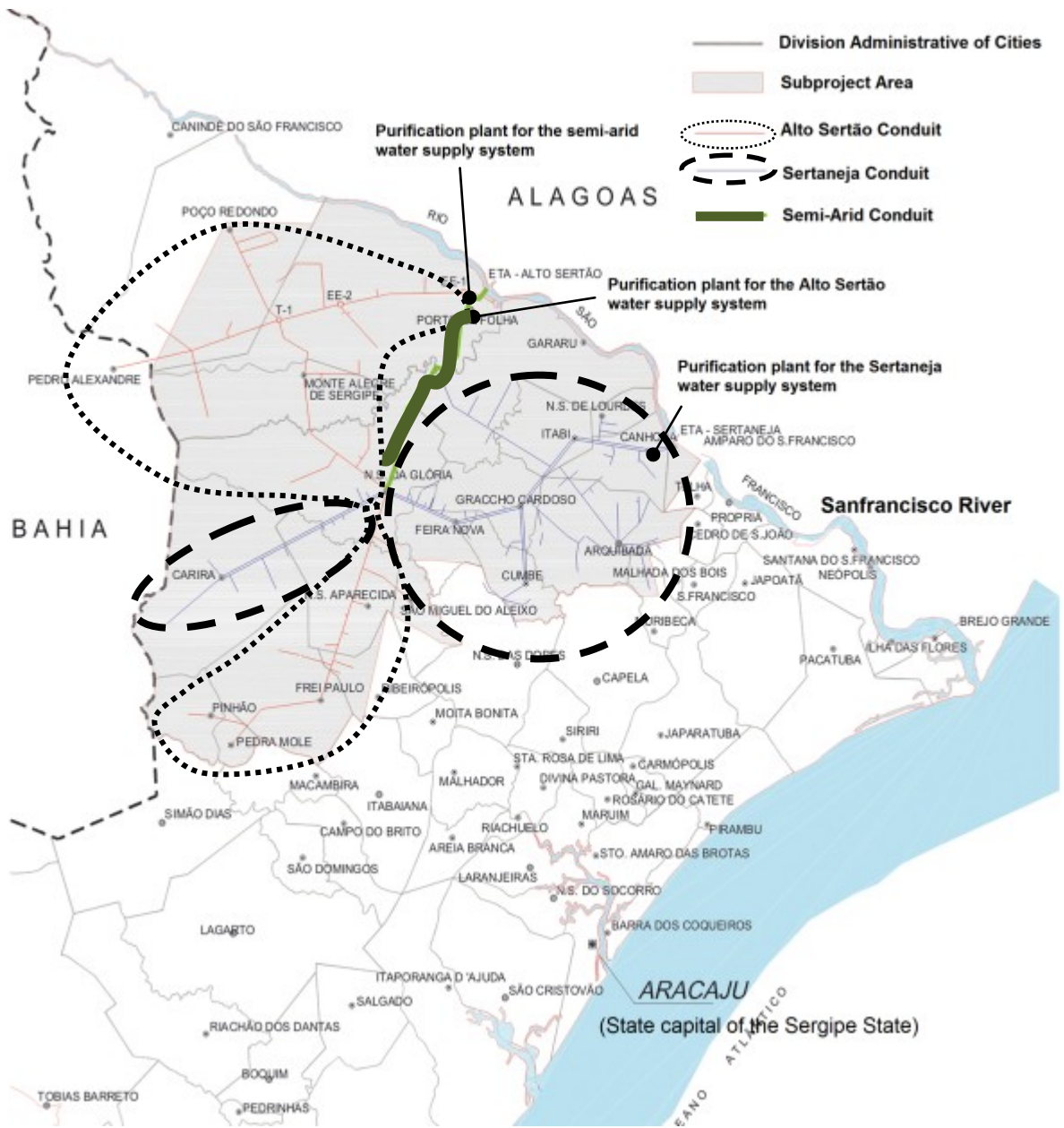
The centers for the management of the water supply system have been established in the Porto-Novo purification plant and Santana City.

Source: Project Completion Report for the PROAGUA Subproject in Bahia State (The water supply system for Santana City, Canapolis City, Serra Dourada City, Tabocas 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 Glória.

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 scale¹⁰ 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
Piauí	221	127	11.2%	57.5%
Ceará	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.

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 m³ in 2010 to 4,007 m³ 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 color¹⁸ 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 color²⁵ 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 survey²⁶ 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 evaluation²⁷ 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 m³ per second and the amount of intake was 335 m³ 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 system³³ and the Sertaneja water conveyance system³⁴ 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 plant 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	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.
Amount of intake from water source (1/s)	280	280	
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)

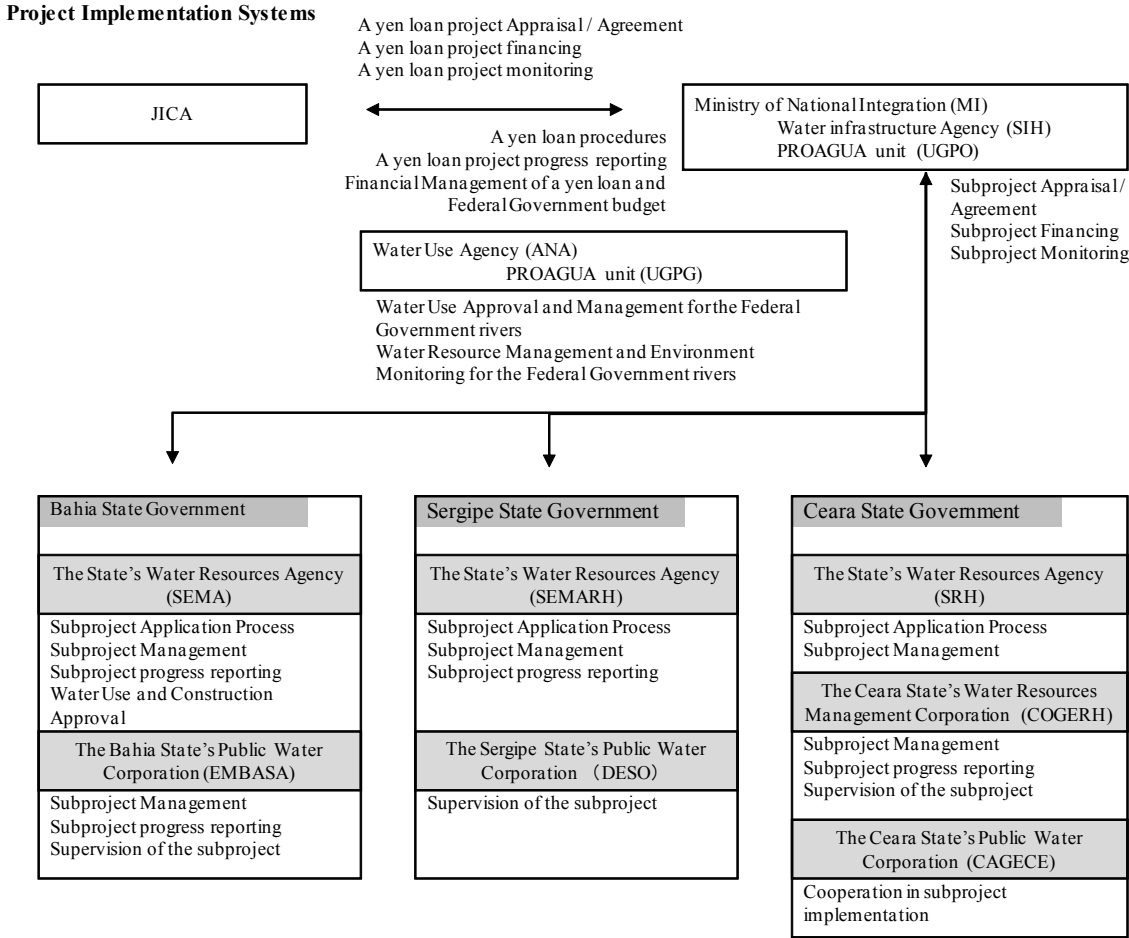
The implementing agencies of this project were the PROAGUA unit of the Ministry of National Integration's water infrastructure agency (hereinafter referred to as "UGPO"), which supervised the subprojects, and the water use agency's PROAGUA unit (hereinafter referred to as "UGPG"). UGPO is an organization 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 PROAGUA 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.

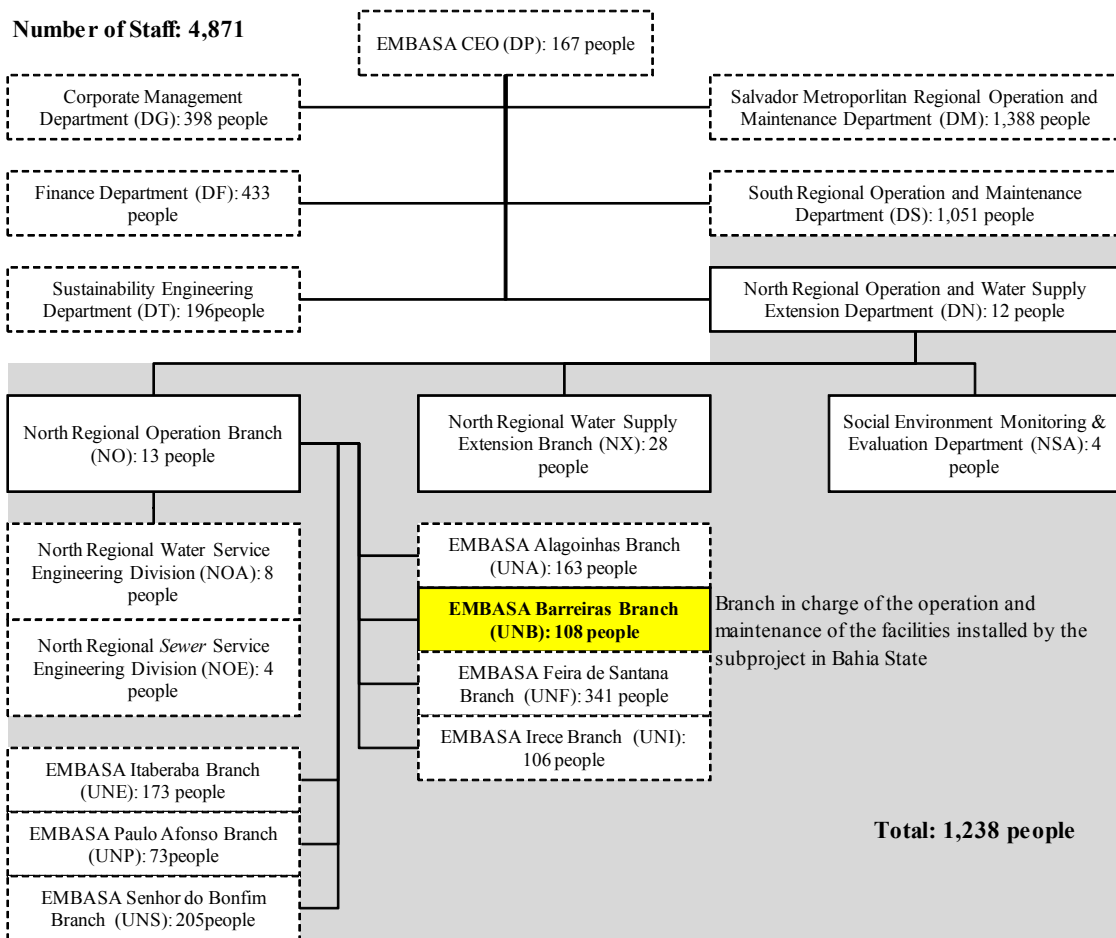


Source: Created by the Evaluators through interviews with the Ministry of National Integration

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:



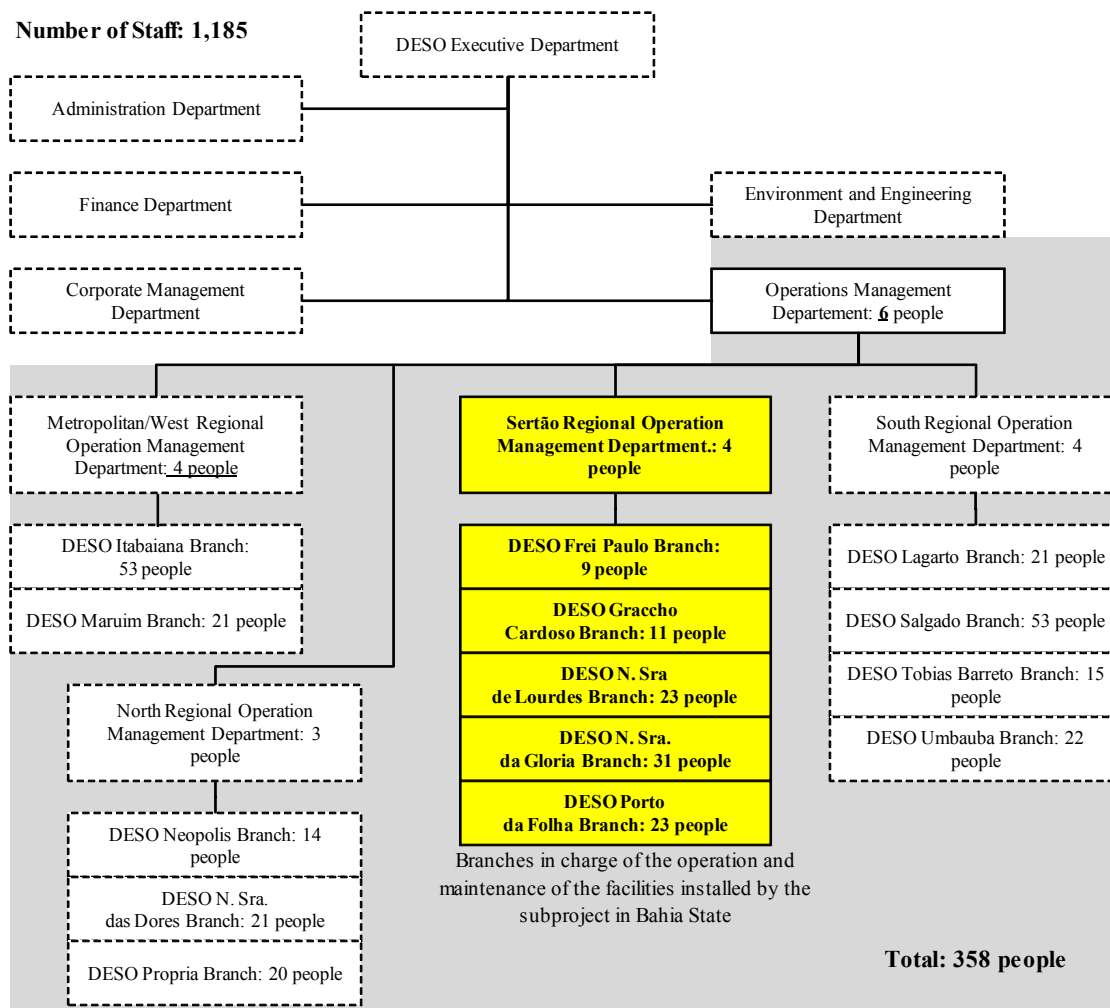
Source: Organization chart (2014) provided by the Public Water Corporation in Bahia State (EMBASA)

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 automated⁴³ 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.

Comparison of the Original and Actual Scope of the Project

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

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