Brazil

Ex-Post Evaluation of Japanese ODA Loan

Parana State Environmental Improvement Project

External Evaluator: Choshin Haneji, Japan Development Service Co., Ltd.

0. Summary

This project was implemented with the objectives of improving the living environment for citizens and water quality in rivers and coastal areas through the construction of water supply system and sewage treatment system facilities in Curitiba Metropolitan Area and the coastal area of Parana State, which was suffering from chronic water outages due to low water supply capacity and less developed sewerage. The project was sufficiently consistent with the development policies and development needs of the Federal Government of Brazil and Parana State Government, which regarded public water supply and sewage system construction as priority issues, as well as Japan's ODA policy, therefore its relevance is high. Throughout the implementation of the project, water shortage problems in the target area were greatly improved. Particularly in the coastal area, coverage increase of sewage treatment resulted in a great improvement in the quality of river water flowing to the coast, thereby enabling bathing to be permitted at more bathing beaches. Thus, its effectiveness is also high. The project cost was mostly as planned. However, the project period greatly exceeded the plan due to delays in the land expropriation procedure for dam construction and the securing of environmental permits for water and sewage treatment facilities. Therefore efficiency of the project is fair. Since there are no problems concerning operation maintenance in terms of setup, technology and finances, sustainability of the project effects is high. In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project Location

Miringuava Water Treatment Plant

1.1 Background

Parana State (Estado do Paraná) in southeast Brazil had a public water supply coverage rate of 92% and a sewerage coverage rate of 25% in 1997. Both these values were below the national averages for Brazil (96% and 34%), and there was an urgent need to improve the situation because it was causing deterioration of the living environment and natural environment.

The public water supply in Curitiba Metropolitan Area (Região Metropolitana de Curitiba) displayed a supply and demand disparity of 25% during the summer season from December to February and 10% during the winter season from June to August, causing restrictions to be imposed on the water supply. Water supply for 24-hours a day was only possible on 9% of the overall water supply system in Curitiba Metropolitan Area. As for the sewage treatment system, the coverage rate was only 25%, and discharges of untreated sewage were causing extreme water pollution in rivers.

Furthermore, because the population in the coastal area of Parana (Litoral do Paraná) increased by approximately fivefold during the summer tourism season, water shortages became even more critical. Similarly, sewage treatment capacity was insufficient due to the deterioration of existing sewage treatment facilities.

1.2 Project Outline

The project aimed to improve the living environment for citizens, preserve water quality, prevent water pollution in rivers and coastal areas, and thereby contribute to environmental improvement through the construction of water supply system and sewage treatment system facilities in Curitiba Metropolitan Area and the coastal area of Parana State.[1]

The project targeted 6 municipalities in Curitiba Metropolitan Area and 5 coastal municipalities for construction of water supply system, and 12 municipalities in Curitiba Metropolitan Area and 5 coastal municipalities for construction of the sewage treatment system. Table 1 shows the target works in each target area, and Figure 1 indicates the locations of the main project facilities.

[1] At the time of appraisal, a component entailing collection and treatment of prohibited agricultural chemicals and used chemical containers was included, however, resolution of this problem by the Brazilian side was subsequently confirmed in 2001. In 2004, the project underwent review and this component was removed from the contents.

Table 1　Project Target Areas

Area	Curitiba Metropolitan Area	Coastal Area
Water supply system construction	- Curitiba Municipality (9 districts) - Colombo Municipality - Campina Grande do Sul Municipality - Quatro Barras Municipality - Pinhais Municipality - Piraquara Municipality	- Guaraqueçaba Municipality - Morretes Municipality - Pontal do Paraná Municipality - Matinhos Municipality - Guaratuba Municipality
Sewage treatment system construction	- Curitiba Municipality (72 districts, industrial district) - Colombo Municipality - Campina Grande do Sul Municipality - Quatro Barras Municipality - Pinhais Municipality - Piraquara Municipality - São José dos Pinhais Municipality - Fazenda Rio Grande Municipality - Araucária Municipality - Campo Largo Municipality - Campo Magro Municipality - Almirante Tamandaré Municipality	- Guaraqueçaba Municipality - Morretes Municipality - Pontal do Paraná Municipality - Matinhos Municipality - Guaratuba Municipality

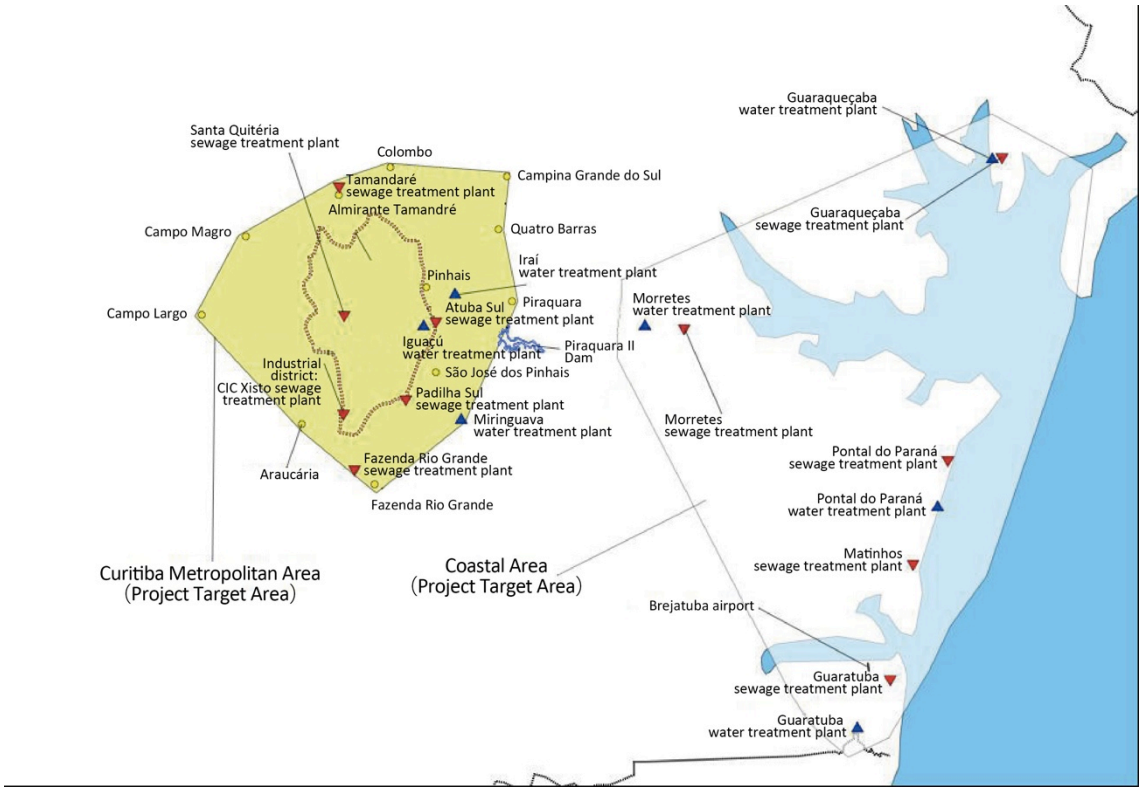

Figure 1　Map of the Water Supply and Sewage Treatment Systems Construction Target Areas and Facilities

Loan Approved Amount/ Disbursed Amount	23,686 million yen / 23,686 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	August, 1996 / January, 1998
Terms and Conditions	Interest Rate: 4% Repayment Period: 25 years (Grace Period: 7 years) Conditions for Procurement: General Untied
Borrower / Executing Agency	Parana State, Federative Republic of Brazil/ The Paraná State Sanitation Company (SANEPAR)
Final Disbursement Date	May, 2099
Main Contractor (Over 1 billion yen)	① Constructora Itau (Brazil) ② Queiroz Galvao (Brazil) - Pasarelli (Brazil) (JV) ③ OTV (Brazil)- Itajui (Brazil) (JV) ④ CEBSE (Brazil)- LFM (Brazil) (JV) ⑤ GEL (Brazil)- ACMA (Brazil)- COMIM） (Brazil) (JV) ⑥ GEL (Brazil)- ACMA (Brazil)- NWM (Brazil) (JV) ⑦ LFM (Brazil)- DM (Brazil)- SEF (Brazil) (JV) ⑧ SAENGE (Brazil)- CTL (Brazil) (JV) ⑨ J. Malucelli (Brazil)- Fuad Rassi (Brazil) (JV) ⑩ Itajui Engenharia de Obra (Brazil) ⑪ DM Consultora de Obras (Brazil) ⑫ GEL (Brazil)- ACMA (Brazil)- Formato (Brazil) (JV) ⑬ PAVIBRAS Pavimentacao e Obras (Brazil)
Main Consultant (Over 100 million yen)	① Engevix Engenharia (Brazil)- Chuo Kaihatsu Corporation (Japan)- Environmental Technology Consultant (Japan)- Black & Veach International (US) Estudos Tecnicos e Projetos (Brazil)- Esteio Engenharia e Aerolevantamentos (Brazil)- RDR Consultores Associados (Brazil) (JV) ② Multiservice Engenharia (Brazil)- Concremat Engenharia e Tecnologia (Brazil)- Yachiyo Engineering (Japan)- Ecosol Projetos de Engenharia, Saneamento e Meio Ambiente (Brazil) (JV)
Feasibility Studies, etc.	None
Related projects (if any)	None

2. Outline of the Evaluation Study

2.1 External Evaluator

Choshin Haneji(Japan Development Service Co., Ltd.)

2.2 Duration of Evaluation Study

Duration of the Study: September, 2011 – December, 2012

Duration of the Field Study: March 25, 2012 – April 15, 2012, July 22, 2012 – July 27, 2012

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

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance with the Development Plan of Brazil

Construction of water supply and sewage treatment systems in Parana State is referred in the multiple-year plan (Plano Plurianual) pledged by the Federative Government of Brazil. At the time of appraisal, the plan for 1996-1999 aimed to modernize and expand the coverage rate of the water supply and sewage treatment systems, whereas the plan for 2012-2015 at the time of the ex-post evaluation aims to enhance water supply and sewage treatment system development from the viewpoints of improving the health of citizens and addressing environmental pollution. Moreover, as is referred in the state's multiple-year plan (2012-2015), the Environment and Water Resources Agency (SEMA) is advancing diffusion at the level of tributary river basin units based on the river basin-unit management method introduced under the Parana State water resources policy (promulgated in 1999), which continues to regard the water supply and sewage treatment system construction utility as an important issue.

3.1.2 Relevance with the Development Needs of Brazil

In Parana State and the project target areas, at the time of the appraisal, water shortages and water pollution in rivers and coastal areas were at critical levels. At the time of the ex-post evaluation, progress is being made in the construction of water supply and sewage treatment systems. However, concerning construction of water supply system, although the water outages that were occurring at the time of appraisal have been resolved, because the annual rate of population increase in the target areas ranges between 1.0-20.3% as opposed to the original forecast of 1.55%, it is forecasted that disparity between demand and supply will arise in the areas where population growth is most extreme. Similarly, concerning sewage treatment systems, compared to the target for Curitiba Metropolitan Area of 60% (2010), the mean coverage rate in 2011 was 81.5%, and the rate in individual districts varied between

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

[3] ③: High, ②: Fair, ①: Low

18.8% and 100%. In coastal areas also, the project resulted in a higher coverage rate of sewage treatment systems (no target value was set), however, depending on the city concerned, the rate fluctuates from 26.4% to 100%. Therefore, sewage system construction remains an important issue in the areas that continue to have a low rate of coverage.

3.1.3 Relevance with Japan's ODA Policy

The project has the objective to provide safe water supply and to reduce impacts on river water quality through conduction of sewage treatment; it responds to the need for development of water supply and sewage treatment systems in line with economic and social development; and it contributes to the balancing development with the environment. Also, according to the overseas economic cooperation work implementation policy for Brazil (1999) at the time of appraisal of the project contents and plan (2001 and 2004) mentioned above (see footnote 1), it was necessary to balance development with environment in terms of realizing a sustainable economy and society; therefore, support for sustainable development is highly relevant to Japan's ODA policy.

From above, this project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Effectiveness[4] (Rating: ③)

3.2.1 Quantitative Effects (Results from Operation and Effect Indicators)

3.2.1.1 Water Supply System

(1) Population served[5]

The number of beneficiaries who have received water supply services due to the project is approximately 1.12 million (2011), representing an increase of approximately 380,000 (51.3%) over the number at the time of the appraisal (1998)[6].

(2) Amount of Water Supply

The overall amount of water supply increased by more than 30% (compared to the amount at the time of appraisal). Meanwhile, water supply per capita over the same period increased by 4.2-44.3% in the 5 target municipalities of Curitiba Metropolitan Area other than Curitiba Municipality, however, the water supply coverage rate in the 9 districts of Curitiba Municipality and the coastal area, where the rate was almost 100% at the time of appraisal

[4] Sub-rating for effectiveness is to be put with consideration of impact.
[5] Comparison of actual values (because no target value for population served was set)
[6] Population in the target area increased from 745,000 to 1,120,000 over the same period. The public water supply coverage rate reached 100% as indicated in Table 2.

fell slightly due to population increase (up by 73.4% compared to the time of appraisal) (-3.3%).

(3) Improvement in the water supply coverage rate

The target facilities of the project were successively completed between 2003 and 2008, and the water supply coverage rate[7] in each area has attained 100% in line with the completion of works. The following table shows this progress.

In the target 9 districts of Curitiba Municipality, Piraquara Municipality and Colombo Municipality, the rotating water outages that were in force at the time of appraisal have been abolished and major improvement is recognized; however, in other areas, minor water outages are sometimes enforced during the dry season (January to March). However, whereas it previously took a few days for water supply services to be resumed after water outages, this has been reduced to less than 4 hours in the project target areas. Meanwhile, in Colombo Municipality and Campina Grande do Sul Municipality in Curitiba Metropolitan Area and the 5 target cities in the coastal area, there are currently no water outages at all.

Also, according to the beneficiaries survey, 68.3% of respondents indicated that water supply services had improved as a result of the project (65% in Curitiba Metropolitan Area and 80% in the coastal area)[8]. Meanwhile, 51.2% responded that water shortages had been resolved, and 7.3% indicated that there were no water outages at all.

Table 2 Movements in the Water Supply Coverage Rate

Area	1998 (actual value at time of appraisal)	2005 (Actual value)	2010 (Target)	2011 (Actual value)
Curitiba Municipality (9 districts)	99.60%	99.98%	98%	100.00%
Piraquara Municipality	98.04%	98.04%		100.00%
Pinhais Municipality	98.28%	99.99%		100.00%
Colombo Municipality	97.29%	97.29%		100.00%
Campina Grande do Sul Municipality	90.01%	94.57%		100.00%
Quatro Barras Municipality	91.25%	92.62%		100.00%
Coastal area: Guaraqueçaba Municipality	95.01%	100.00%		100.00%
Coastal area: Morretes Municipality	94.37%	100.00%		100.00%
Coastal area: Pontal do Paraná Municipality	98.66%	100.00%		100.00%
Coastal area: Matinhos Municipality	96.57%	100.00%		100.00%
Coastal area: Guaratuba Municipality	100.00%	100.00%		100.00%

Source: SANEPAR

[7] Coverage rate here targets the houses and industrial and commercial facilities registered in land registers held by each municipality. Therefore, houses located in riverbank areas and illegal squatter districts (favela) are not included.

[8] 10.8% of respondents indicated “no change.”

(4) Rate of Facility Utilization (water treatment plants)

In line with fluctuations in demand for water supply, there are also differences in the utilization rates of water treatment facilities. In the coastal municipalities of Morretes and Guaraqueçaba, since demand is increasing in line with annual population growth rates of 7.8% and 4.7% respectively, the rate of facility utilization is high and it is necessary to expand the systems. Meanwhile, the mean rate of facility utilization of the water treatment facilities in Miringuava, Guaratuba and Pontal do Paraná is much lower than the treatment capacity. This is because, there is insufficient flow at the water intake point in the case of Miringuava treatment plant; however, the utilization rate is expected to improve as a result of construction of Miringuava Dam that is planned by SANEPAR. Moreover, since the design values for Guaratuba treatment plant and Pontal do Parana treatment plant are set corresponding to the greatly increased demand during the summer season, the utilization rate for the entire year is less than 50%. The following table shows the rate of facility utilization (see Figure 1 for the locations of facilities).

Table 3 Utilization of Water Treatment Facilities

Water supply system facilities	Treatment capacity (L/s)		Mean treatment level (2011)		Maximum treatment level (2011)	
	Design	Actual	L/s	Utilization rate	L/s	Utilization rate
Iraí water treatment plant	4,200	3,200	2,381	74.4%	2,900	90.6%
Iguaçú water treatment plant	3,500	3,500	2,768	79.1%	3,500	100.0%
Miringuava water treatment plant	0	1,000	750	37.5%	1,200	60.0%
Guaraqueçaba water treatment plant	10	10	9	90.0%	10	100.0%
Morretes water treatment plant	35	35	35	100.0%	37	105.7%
Pontal do Paraná water treatment plant	800	800	396	49.5%	655	81.9%
Guaratuba water treatment plant	260	260	112	43.1%	216	83.1%

Source: SANEPAR

3.2.1.2 Sewage Treatment System

(1) Population Served[9]

The number of beneficiaries who have received sewage treatment services due to the project is approximately 1.40 million (2011), representing an increase of approximately 733,000 (110%) over the number at the time of the appraisal (1998)[10].

[9] Comparison of actual values (because no target values were set for the sanitary sewage treatment population).

[10] Population in the target area increased from 1.32 million to 1.83 million (38.9%) over the same period. The sewage treatment system coverage rate reached 76.6% as indicated in Table 4.

(2) Improvement in the sewage treatment system coverage rate

The target areas of sewage treatment system construction in Curitiba Metropolitan Area were 72 districts of Curitiba Municipality, 1 industrial district and 11 municipalities. The sewerage coverage rate fluctuates greatly between 18.8% and 100%; however, the simple mean rate has increased to 81.5%. Out of the 72 target districts in Curitiba Municipality, 57 districts have a diffusion rate of 80% or higher. Meanwhile, the coverage rate is lowest in Almirante Tamandaré Municipality (18.8%), Campo Magro Municipality (22.5%) and Araucária Municipality (37.2%), which are located in the sparsely populated western part of Curitiba Metropolitan Area; moreover, Campo Magro and Araucária are situated relatively far away from sewage treatment facilities. In the coastal area also, the sewerage coverage rate increased to between 51.1~100% in all districts except for Pontal do Paraná Municipality. In Pontal do Paraná Municipality, the sewerage coverage rate has remained low (26.4%) due to rapid population growth even in coastal parts (population increased by 607% compared to the time of appraisal). The following table shows planned and actual values.

Table 4 Movements in Sewage Treatment Coverage Rate

Area	1998 (actual value at time of appraisal)	2010 (Target)	2011 (Actual value)
Curitiba Metropolitan Area (minimum level district)	0.0%	60%	18.8%
Curitiba Metropolitan Area (mean value)	52.1%		81.5%
Curitiba Metropolitan Area (maximum level district)	100.0%		100.0%
Coastal area: Matinhos Municipality	33.8%	Not set	51.1%
Coastal area: Guaraqueçaba Municipality	0.0%		100.0%
Coastal area: Guaratuba Municipality	31.9%		56.4%
Coastal area: Morretes Municipality	15.0%		53.0%
Coastal area: Pontal do Paraná Municipality	0.0%		26.4%
Coastal area (entire target area)	25.0%		46.4%
Target area of project	50.4%		76.6%

Source: SANEPAR

(3) Rate of Facility Utilization: sewage treatment plants

Most sewage treatment facilities show seasonal fluctuations in utilization rates but they have spare capacity over the entire year. However, in the coastal municipality of Morretes, since the annual mean utilization rate is 93.3% and the peak treatment flow exceeds the specified treatment capacity, there is a need to expand the facilities. The low utilization rate of Fazenda Rio Grande treatment plant is due to the fact that the sewage treatment system coverage rate in that area is only 40.4%, although SANEPAR is advancing the expansion plan. As for the treatment plants in Pontal do Paraná, Matinhos and Guaratuba, as with the

water treatment facilities, since the design utilization rate has been set corresponding to the higher demand during the summer tourist season, the year-round utilization rate is less than 50%. The sewage treatment system coverage rate in Pontal do Paraná is only 26.4% because population increased by 607% between the time of appraisal and time of the ex-post evaluation, however, if the sewerage expansion plans currently being advanced by SANEPAR are realized, the utilization rate of treatment plants will increase. The following table shows the rates of facility utilization (see Figure 1 for the locations of facilities).

Table 5 Utilization of Sewage Treatment System Facilities

Sewerage facilities	Treatment capacity (L/s)		Mean treatment level (2011)		Maximum treatment level (2011)	
	Design	Actual	L/s	Utilization rate	L/s	Utilization rate
Industrial district: CIC Xisto treatment plant	600	600	382	63.7%	448	74.7%
Padilha Sul treatment plant	440	440	289	65.7%	376	85.5%
Tamandaré treatment plant	70	70	42	60.0%	49	70.0%
Fazenda Rio Grande treatment plant	260	260	78	30.0%	142	54.6%
Atuba Sul treatment plant	1,450	1,450	981	67.7%	1,143	78.8%
Santa Quitéria treatment plant	600	600	403	67.2%	465	77.5%
Guaraqueçaba Municipality treatment plant	12	12	7	58.3%	12	100.0%
Morretes Municipality treatment plant	30	30	28	93.3%	31	103.3%
Pontal do Paraná Municipality treatment plant	140	140	20	14.3%	75	53.6%
Matinhos Municipality treatment plant	210	210	98	46.7%	168	80.0%
Guaratuba Municipality treatment plant	210	210	102	48.6%	181	86.2%

Source: SANEPAR

3.2.2 Qualitative Effects

(1) Water quality in water supply system

The following table shows data from monitoring of the quality of water supplied from water treatment facilities in Curitiba Metropolitan Area. This shows that the water satisfies all potable water quality standards, and the situation is the same in water treatment facilities in the coastal area. Since these standards are at the same level as or stricter than the permissible values prescribed in guidelines by the World Health Organization (WHO), it can be said that safety water is being supplied. In the beneficiaries survey that was implemented for the relation to the evaluation of project effectiveness, 120 people were targeted and a door-to-door questionnaire survey was conducted of households randomly selected in proportion to the population in each target area (implementation period: March 26-April 13, 2012). Out of the respondents, 20.7% indicated that water quality had improved.

Table 6 Results of Monitoring Quality of Treated Water (2011)

Item (unit)	Potable water quality standard	WHO guideline	Iraí plant		Iguaçú plant	
			Feb.	Sept.	Feb.	Sept.
Color (TCU)	<15	<15	2.5	2.5	5	2.5
Cyanide (mg/L)	<0.07	<0.17	<0.002	0.005	<0.002	<0.002
Fluorine (mg/L)	[0.6 , 1.1]	<1.5	0.7	0.7	0.8	0.7
Nitrate nitrogen (mg/L)	< 0	<50	0.25	1.11	0.21	0.31
Turbidity (NTU)	<1	<1	0.27	0.37	0.36	0.33
Surfactant agent (mg/L)	<0.5	No value	<0.025	<0.025	<0.025	0.05
Hydrochloric acid (mg/L)	<250	<250	10.8	17.5	4.4	4.8
Hardness-$CaCO_3$ (mg/L)	<500	<500	22.7	34.9	24.6	28.8
Hydrogen-ion exponent (pH)	No specification	[6.5, 8.5]	6.7	6.5	6.5	6.2
Suspended solids (mg/L)	<1,000	<1,000	90	106	38	72
Sulfate (mg/L)	<400	<1,000	<10.0	<10.0	<10.0	18.5
Nitrogen nitrite (mg/L)	<1	<3	<0.005	<0.005	<0.005	<0.005
Total suspended solids (mg/L)	No specification	No guideline	90	108	41	72
Ammonia (mg/L)	<1.5	<1.5	0.15	<0.05	0.24	<0.05
Hydrogen sulfide (mg/L)	<0.05	<0.1	<0.005	0.031	<0.005	0.015

Source: SANEPAR

(2) Sewage effluent quality

Concerning sewage, effluent from all sewage treatment facilities satisfies standards as indicated below. According to SANEPAR, it sets stricter values than those set by the federal government with respect to biological oxygen demand (BOD), and it also measures the chemical oxygen demand (COD) level, which isn't even included in federal government standards. Effluent standards at sewage treatment facilities in Brazil prescribe standard values for pH, water temperature and BOD level and the number of control items is smaller than compared to Japan; however, concerning the most important BOD level, the permissible value of less than 120 mg/L is more stringent than the level of 160 mg/L (daily mean 120 mg/L) in Japan. Meanwhile, in Brazil, no standard is prescribed concerning COD, although SANEPAR prescribes an internal level of 120 mg/L, which again is harsher than the corresponding standard of 160 mg/L (daily mean 120 mg/L) in Japan.

Table 7 Situation regarding Compliance to Effluent Standards (2011)

Sewage treatment facilities	BOD (mg/L)	COD (mg/L)
Effluent standard (Federal Environment Council Order 430 Article 21)	120.0	No specification
Industrial district: CIC Xisto treatment plant	60.0 or less	120.0 or less
Padilha Sul treatment plant	60.0 or less	120.0 or less
Tamandaré treatment plant	60.0 or less	120.0 or less
Fazenda Rio Grande treatment plant	60.0 or less	120.0 or less
Atuba Sul treatment plant	60.0 or less	120.0 or less
Santa Quitéria treatment plant	60.0 or less	120.0 or less
Guaraqueçaba Municipality treatment plant	17.9	39.4
Morretes Municipality treatment plant	22.7	36.2
Pontal do Paraná Municipality treatment plant	24.2	36.4
Matinhos Municipality treatment plant	22.2	41.3
Guaratuba Municipality treatment plant	24.3	40.2

Source: SANEPAR

3.3 Impact

3.3.1 Intended Impacts

3.3.1.1 Improvement of the Living Environment and Sanitary Environment

Concerning the effect of the water supply component of the project, most of the residents targeted in the beneficiaries survey indicated that water supply services had improved, specifically citing increased amount of water supply, better water quality, resolution of water outages, improvement of water pressure and so forth. In particular, many people (62.5%) responded that the effort exerted in procuring water had been resolved. Moreover, the majority (59.2%) of respondents indicated that outbreaks of waterborne infections had decreased.

3.3.1.2 Improvement of Water Quality in Effluent-receiving Rivers and Coastal Areas

In Curitiba Metropolitan Area, judging from conditions at the time of the appraisal, river water quality is generally deteriorated. Looking at the results of the beneficiaries survey, 60% of respondents indicated that water quality had improved in coastal areas, however, this figure was only 25% in Curitiba Metropolitan Area. However, as reported by Parana State Environment Agency (IAP), since pollution of rivers is also caused by leachate from solid wastes, industrial wastewater discharged by illegal operators and other factors, it is difficult to clarify the relationship between coverage rate of the sewage system and river quality.

Meanwhile, in coastal areas, since water quality in rivers flowing down to the coast has improved greatly as a result of the coverage of sewage treatment, seaside bathing has become possible, more and more bathing resorts have opened, and resort development is advancing in the 5 targeted coastal municipalities (according to IAP information and hearings with coastal municipalities).

3.3.2 Other Impacts

3.3.2.1 Impacts on the natural environment

Due to the construction of Piraquara II Dam 5.64 square kilometers of land were submerged, however, the location with the least impact was selected based on environmental impact assessment. Moreover, in consideration of the landscape and the preservation of ecosystems, afforestation activities using local species are being conducted. Moreover, as was mentioned above, since there are other pollution sources apart from sewage, even though recovery of river water quality cannot be recognized, the contamination of water has been mitigated as a result of the treatment of sewage. Therefore, no extreme negative impacts due to implementation of the project can be confirmed.

3.3.2.2 Land acquisition and resettlement

Regardless of expropriation of 5.64 square kilometers of land, resettlement of residents does not occur with the construction of Piraquara II Dam. Compensation was paid to landowners based on the expropriation regulations. Moreover, inherent with the construction of Piraquara II Dam, public hearings concerning the project contents and construction of tourism facilities and so on as social support for communities were conducted, for the residents of Piraquara, under supervision by the IAP. The public facilities that were relocated because of dam construction comprised power distribution lines, telephone and communications lines and access roads.

Summing up, since implementation of the project led to improvement of water supply and sewerage services in the target areas and improvement of the living environment for residents through enhancing water quality in the coastal area and so on, the planned effects were generally realized and the project has largely achieved its objectives, therefore its effectiveness is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The following sections indicate the planned and actual outputs under each of the project components.

3.4.1.1 Curitiba Metropolitan Area Water Supply System

The following table indicates the planned and actual contents of water supply system in Curitiba Metropolitan Area. In Curitiba Metropolitan Area, the demand for water is covered by Iraí treatment plant (treatment capacity: 3,200 L/s) in the northeast, Iguaçú treatment plant (treatment capacity: 3,500 L/s) in the center, and Miringuava treatment plant (treatment capacity: 1,000 L/s) in the southeast of the area. In terms of water main facilities, larger-diameter mains and more distribution pumps than planned have been installed. These facilities were installed in response to the higher demand in industrial areas that was gauged following the project plan.

Table 8 Curitiba Metropolitan Area Water Supply System

Item	Plan	Actual
Reservoir facilities	・ Piraquara II Dam	As planned
Intake facilities	・ Intake channel: Iraí River-intake, length 256 m, width 17-37 m ・ Intake gate ・ Raw water pump: 170 CV x 5 units	・ Intake channel: Iraí River-intake, length 256 m, width 17-37 m ・ Intake gate ・ Raw water pump: 172 CV x 5 units
Conveyance facilities	Headrace: Intake-Iraí River- treatment plant	As planned
Water treatment facilities	・ Iraí treatment plant: treatment capacity 3.2 m^3/s ・ Miringuava treatment plant: treatment capacity 1.0 m^3/s ・ Iguaçú treatment plant expansion ・ Iraí treated water reservoir: 8,000 + 12,000 m^3 ・ Miringuava treated water reservoir: 10,000 m^3	As planned
Aqueduct facilities	・ Water mains: ϕ 150-1,100 mm, length 115.48 km ・ Treated water pumps: 29	・ Water mains: ϕ 400-1,200 mm, length: 127.65 km ・ Treated water pumps: 39
Distribution facilities	・ Distribution pipes: length 310.38 km ・ Distribution reservoirs: 24 reservoirs, 1 tank, total capacity 190,000 m^3	・ Distribution pipes: length 358.42 km ・ Distribution reservoirs: 24 reservoirs, 1 tank, total capacity 191,500 m^3

Source: SANEPAR

3.4.1.2 Coastal Area Water Supply System

The following table indicates the planned and actual contents of water supply system in the coastal area. In the coastal area, the demand for water is covered by the water treatment facilities that were constructed in the 5 target municipalities in the project. The supply capacity is as planned at the time of appraisal, however, the number of reservoir facilities and total length of pipes are slightly less than planned because the water distribution and aqueduct system was revised to a more efficient model.

Table 9 Water Supply System in Coastal Areas

Item	Planned	Actual
Water treatment facilities	・ Intake facilities: 4 locations ・ Treatment plants: 4 locations	As planned
Reservoir facilities	・ Treated water reservoirs/distribution reservoirs, etc.: 12 locations, capacity 16,150 m^3	・ Treated water reservoirs/distribution reservoirs, etc.: 10 locations, capacity 15,350 m^3
Pumping stations	・ For intake and distribution: 20 locations	・ For intake and distribution: 22 locations
Aqueduct and distribution facilities	・ Aqueduct/water mains: 46,600 m ・ Distribution pipes: 93,031 m	・ Aqueduct/water mains: 41,830 m ・ Distribution pipes: 81,328 m

Source: SANEPAR

3.4.1.3 Curitiba Metropolitan Area Sewage Treatment System

As is indicated in the table below, the sewage treatment system has been developed almost exactly as planned. In Curitiba Metropolitan Area, sewage treatment facilities were constructed at 6 locations, namely the industrial district: CIC Xisto treatment plant (treatment capacity: 600 L/s), Padilha Sul treatment plant (treatment capacity: 440 L/s), Tamandaré treatment plant (treatment capacity: 70 L/s), Fazenda Rio Grande treatment plant (treatment capacity: 260 L/s), Santa Quitéria treatment plant (treatment capacity: 600 L/s), and Atuba Sul treatment plant (treatment capacity: 1,450 L/s).

Table 10 Sewage Treatment System in Curitiba Metropolitan Area

Item	Planned	Actual
Collecting systems	Length 1,840,344 m	Length 1,776,050 m
Service connections	100,799 locations	100,658 locations
Trunk collectors/ interceptors	・ ϕ 150 mm- ϕ 800 mm ・ Length 176,185 m	・ ϕ 150 mm-ϕ 800 mm ・ Length 175,393
Forced mains	・ ϕ 50 mm- ϕ 400 mm ・ Length 41,797 m	・ ϕ 50 mm- ϕ 400 mm ・ Length 41,691 m
Pump stations	New: 23 locations	As planned
Sewage treatment plants	・ New: 4 locations (treatment capacity: 1,275 L/s) ・ Expanded: 2 locations (treatment capacity: 2,050 L/s)	・ New: 4 locations (treatment capacity: 1,370 L/s) ・ Expanded: 2 locations (treatment capacity: 2,050 L/s)

Source: SANEPAR

3.4.1.4 Coastal Area Sewage Treatment System

In the coastal area also, sewage treatment facilities were constructed as planned in each of the 5 targeted municipalities (see Figure 1 for locations). The following table shows the planned and actual contents of the sewage treatment system development for this area. The number of facilities turned out to be greater than planned due to the construction of Brejatuba Airport in Guaratuba Municipality and revision of land use plans in Pontal do Paraná Municipality.

Table 11 Sewage Treatment System in the Coastal Area

Item	Planned	Actual
Sewage treatment plants	・ New: 5 locations (treatment capacity: 600 L/s)	・ New: 5 locations (treatment capacity: 602L/s)
Pump stations	・ 26 locations	・ 29 locations
Trunk collectors/ interceptors	・ Length 18,412 m	・ Length 20,956 m
Forced mains	・ 34,830 m	・ 38,455 m
Collecting systems	・ New 211,574 m	・ New 256,030 m
Service connections	・ 8,025 locations	・ 12,458 locations

Source: SANEPAR

3.4.2 Project Inputs

3.4.2.1 Project Cost

The project cost was 99.88% of the planned amount, so it was implemented mostly as planned. The following table shows the planned and actual costs of the project.

Table 12 Project Cost

Item	Planned (million yen)	Actual (million yen)	Difference (million yen)	Change ratio
Civil works costs	44,708	44,641	-67	-0.15%
Curitiba Metropolitan Area water supply system	17,922	17,855	-67	-0.37%
Curitiba Metropolitan Area sewage treatment system	18,696	18,696	0	0%
Coastal area water supply system	2,629	2,629	0	0%
Coastal area sewage treatment system	5,461	5,461	0	0%
Consulting services	6,827	6,827	0	0%
Project management	4,261	4,261	0	0%
Supervision of construction	2,559	2,559	0	0%
Service charge	7	7	0	0%
Contingencies	17	17	0	0%
Management cost, land expropriation cost, tax	3,877	3,877	0	0%
Total	55,429	55,362	-6.7	-0.12%

Source: SANEPAR

3.4.2.2 Project Period

Since a long period of time was required to acquire the necessary environmental permits for construction of the water supply and sewage treatment systems and to procure funds on Brazilian side, the project eventually took 113 months (March 2000-June 2009) to complete, far longer (163%) than the planned period of roughly 69 months (1998-2004). The following table shows the planned and actual project period.

Table 13 Project Period

Item	Planned		Actual		Difference
	Period	Months	Period	Months	Change ratio
Piraquara II Dam	1999-2003	54	2002/11-2008/12	62	+15%
Curitiba Metropolitan Area water supply system I	1998-2002	39	2000/03-2003/02	36	-8%
Curitiba Metropolitan Area water supply system II	1998-2004	69	2002/10-2008/09	72	+4%
Curitiba Metropolitan Area sewage treatment system I	1998-2003	48	2000/08-2003/10	39	-19%
Curitiba Metropolitan Area sewage treatment system II	1999-2004	60	2005/12-2009/06	43	-28%
Coastal area public water supply	1999-2003	51	2002/04-2005/03	36	-29%
Coastal area sewage system	1999-2003	57	2002/05-2006/07	52	-9%
Project overall	1998-2004	69	2000/03-2009/06	113	+63%

Source: SANEPAR

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

Financial Internal Rate of Return (FIRR):

① Water supply system: 11.7%

② Sewage treatment system: 1.1%

③ Water supply and sewage treatment systems combined: 6.4%

The above FIRR was calculated using the same method that was adopted at the time of appraisal, assuming costs consisted on the construction cost and operation and maintenance cost and benefit to comprise revenue from tariffs, and then calculating the rate of return for 15 years. According to JICA internal materials, the FIRR at the time of appraisal was 7% for the water supply system and 8% for the sewage treatment system. However, because these values were estimated before the plan changes entailed by revision of Pequeno Dam to Miringuava Dam which was further abolished, introduction of Miringuava water treatment plant, withdrawal of the coastal municipalities of Paranaguá and Antonina from the project and inclusion of the Pontal do Paraná water supply and sewage treatment systems, it is difficult to make a comparison with situation at the time of the ex-post evaluation. The relatively high FIRR in the water supply sector is thought to be affected by the fact that coverage rates exceeded targets, while the relatively low FIRR in the sewage treatment sector is thought to be impacted by the low coverage rate in coastal areas.

Summing up, although the project cost was within the plan, the project period was exceeded, therefore the project efficiency is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance

SANEPAR operates the water supply and sewage treatment facilities of Parana State by area, and the Metropolitan Area and Coastal Division (GGML) under the umbrella of SANEPAR has jurisdiction over the project target areas. It clearly separates duties between the water supply system and sewage treatment system services and has established a department in charge of maintaining facilities. The water supply department (USPD) under the GGML carries out operation of water treatment plants, intake and reservoir facilities and pump stations as well as maintenance of water conveyance, water mains and distribution facilities. The department currently has 66 water treatment plant employees, 88 employees in charge of dams and intake facilities, 99 employees in charge of water distribution system facilities and 6 management employees. Meanwhile, the sewage system department (USEG), also under the GGML, carries out the operation and routine maintenance of sewage treatment plants and

pump stations. It is currently composed of one professional engineer and 21 technicians. The GGML also as an electric and mechanic service unit (USEM), which is responsible for maintaining electric machinery and operation control systems in water treatment plants, sewage treatment plants, pump stations and reservoir facilities. It is currently composed of 11 professional engineers, 87 technicians and 11 management assistants. According to the hearing survey with SANEPAR, there are no problems regarding routine work and response to emergencies and the staff arrangement and maintenance setup are considered to be appropriate.

3.5.2 Technical Aspects of Operation and Maintenance

In the field survey on SANEPAR, the human resources, training plans and maintenance manuals necessary for conducting routine operations are in place, and no salient problems were observed concerning technical aspects of operation and maintenance.

However, in sewage treatment plants not equipped with anaerobic ponds[11] (3 treatment plants in Curitiba Metropolitan Area and 4 in the coastal area), the Dissolved Air Flotation (DAF) (one of the treatment processes)[12] is not functioning. These treatment plants are using the process as sedimentation tank[13] and they have introduced cyclone separators[14] in order to enhance the sludge removal efficiency. Moreover, if necessary, they diluted the treated effluent in order to ensure that effluent standards are satisfied.

The DAF process was adopted as an alternative to the anaerobic pond due to its small area requirements, however, it stopped functioning after operation (the cause has not been identified). Since DAF is not a commonly adopted sewage treatment technology, SANEPAR doesn't have engineers who are familiar with it. Even at sewage treatment plants that have introduced this process, no major problems have occurred because the plants utilize various processes in order to satisfy effluent standards; however, SANEPAR is conducting technical tests on the process at Matinhos sewage treatment plant with a view to restoring the inherent functions of DAF process.

Concerning other technical aspects, no particular problems are occurring.

3.5.3 Financial Aspects of Operation and Maintenance

The financial standing of SANEPAR, which has an independent accounting system, is good; and GGML, which has jurisdiction over the project target area, also has healthy finances. As

[11] A process in which dissimilatory respiration by microbial groups converts organic substances into carbon dioxide and methane

[12] A process in which sludge particles is attached to bubbles generated by air injection, floated and separated

[13] A device for settling and separating solids from liquid in a semi-static state

[14] A device that uses centrifugal force to separate solids (sludge) from liquid (treated effluent)

is shown in the tables below, the cost of maintaining the water supply system accounts for 56.7% of the overall revenue in the GGML operating budget, while the same statistic is 53.9% in the case of the sewerage system, indicating that sufficient profitability is secured. Even if funds do run out, since contingency funds for SANEPAR are secured within the budget of Parana State government, there should be no unease concerning future finances.

Table 14 Financial Indicators for SANEPAR (Unit: million R$)

Item	2009	2010	2011
Total revenue	1,389.40	1,480.27	1,742.40
Total expenditure	1,251.53	1,344.76	1,493.23
Net profit	137.87	135.51	249.17
Net assets	2,035.60	2,179.78	2,310.40
Investment	312.89	397.23	354.18

Source: SANEPAR

Table 15 GGML Revenue and Maintenance Cost in 2011 (Unit: million R$)

Water supply system	Total revenue	Maintenance cost*	Maintenance cost/ Total revenue
Curitiba Metropolitan Area	451,026	251,268	55.7%
Guaraqueçaba	303	267	88.1%
Morretes	1,537	1,117	72.7%
Pontal do Paraná	7,593	4,968	65.4%
Matinhos	9,973	7,690	77.1%
Guaratuba	8,126	5,994	73.8%
Total	478,558	271,304	56.7%
Sewage treatment system	Total revenue	Maintenance cost	Maintenance cost/ Total revenue
Curitiba Metropolitan Area	261,024	137,571	52.7%
Guaraqueçaba	194	242	124.6%
Morretes	575	775	134.7%
Pontal do Paraná	1,559	1,270	81.4%
Matinhos	3,811	3,149	82.6%
Guaratuba	3,464	2,867	82.8%
Total	270,628	145,875	53.9%

(*Maintenance cost includes personnel expenses and depreciation costs).
Source: SANEPAR

3.5.4 Current Status of Operation and Maintenance

Maintenance work is planned and managed by each facility. The annual maintenance timing and frequency by USPD and USEG for each process are determined, and maintenance is conducted according to plans. Moreover, USEM has introduced facilities maintenance planning including preventive inspections of electric systems, and so far no major problems have occurred and the operation and maintenance situation is good.

Summing up, no major problems have been observed in the operation and maintenance

system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons learned and Recommendations

4.1 Conclusions

This project was implemented with the objectives of improving the living environment for citizens and water quality in rivers and coastal areas through the construction of water supply system and sewage treatment system facilities in Curitiba Metropolitan Area and the coastal area of Parana State, which was suffering from chronic water outages due to low water supply capacity and less developed sewerage. The project was sufficiently consistent with the development policies and development needs of the Federal Government of Brazil and Parana State Government, which regarded public water supply and sewage system construction as priority issues, as well as Japan's ODA policy, therefore its relevance is high. Throughout the implementation of the project, water shortage problems in the target area were greatly improved. Particularly in the coastal area, coverage increase of sewage treatment resulted in a great improvement in the quality of river water flowing to the coast, thereby enabling bathing to be permitted at more bathing beaches. Thus, its effectiveness is also high. The project cost was mostly as planned. However, the project period greatly exceeded the plan due to delays in the land expropriation procedure for dam construction and the securing of environmental permits for water and sewage treatment facilities. Therefore efficiency of the project is fair. Since there are no problems concerning operation maintenance in terms of setup, technology and finances, sustainability of the project effects is high. In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency (SANEPAR)

① Considering there are areas where disparity between demand and supply has already arisen as well as, in view of the overall demand and supply, there is a further need for expanding water supply and sewage treatment systems.

② In order to cope with the insufficiency in water supply that is expected to arise in line with increased utilization of Miringuava water treatment plant, which has spare capacity, it is necessary to quickly execute the planned construction of Miringuava Dam in the upstream area of the said plant and thereby increase the water supply capacity.

4.2.2 Recommendations to JICA

None in particular

4.3 Lessons Learned

None in particular

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	・ Curitiba Metropolitan Area water supply system ・ Curitiba Metropolitan Area sewage treatment system ・ Coastal area water supply system ・ Coastal area sewage treatment system ・ Consulting services ・ Contingencies ・ Administration expenses, land expropriation cost, tax	Mostly as planned
2. Project Period	1998–2004 (Approximately 69 months)	March 2000–June 2009 (113 months)
3. Project cost Amount paid in Foreign currency Amount paid in Local currency Total Japanese ODA loan portion Exchange rate	 0 million yen 55,429 million yen (1,034.5R$) 55,429 million yen 23,686 million yen 1R$=52.62 yen (As of 2004)	 0 million yen 55,362 million yen (1,016.5R$) 55,362 million yen 23,686 million yen 1R$=50.73 yen (Average between 1999 to June, 2009)