Preface

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

This volume shows the results of the ex-post evaluation of Japanese ODA loan projects that were mainly completed in fiscal year 2007. The ex-post evaluation was entrusted to external evaluators to ensure objective analysis of the projects' effects and to draw lessons and recommendations to be utilized in similar projects.

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

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

November 2009

Atsuo KURODA
Vice President
Japan International Cooperation Agency (JICA)

Disclaimer

This volume of evaluations shows the result of objective ex-post evaluations made by external evaluators. The views and recommendations herein do not necessarily reflect the official views and opinions of JICA.

Ex-Post Evaluation Report of Japan's ODA Loan Project

Brazil

Tiete River Basin Depollution Project

External Evaluator: Kenichi Inazawa

(Office Mikage, LLC)

Field Survey: April and July 2009

1. Project Profile and Japan's ODA Loan

Map of the Project Area

The Tietê River after River Improvement

1.1 Background

The São Paulo metropolitan area[1] is located in southeastern Brazil. It is the economic and industrial center of the São Paulo State, which has a population of approximately 20 million people. Before the project implementation, the Tietê River, which runs through the middle of the metropolitan area, flooded every year, blocking the principal highway along the riverside and causing major human and economic harm in residential and commercial areas. Flood damage was also severe during times of heavy rain in areas around the Cabuçu de Cima River, a tributary of the Tietê, so this increased the necessity for a flood prevention project for both rivers. At the same time, the concentration of population and industrial development in the metropolitan area meant there was a greater than ever need to secure new water resources and further advance a clean, stable water supply.

1.2 Project Objective

The objective of this project is to mitigate flood damage and promote a stable water supply by implementing river improvement in the Tietê River − which flows in the middle of the São Paulo metropolitan area − and the Cabuçu de Cima River, a tributary of the Tietê River and constructing dam facilities in the upper Tietê River area; thereby contributing to the improvement of life environment for the residents and the development of the regional economy.

[1] The area is located at an altitude of approximately 715−900 meters above sea level. The annual average temperature is around 20 C, and the annual precipitation is 1,400−1,500mm. There are rainy and dry seasons, and half the precipitation concentrates in the rainy season (normally December to March).

1.3 Borrower / Executing Agency

The Water and Electric Energy Department in the State of São Paulo (Departamento De Águas E Energia Elétrica: DAEE), guaranteed by the São Paulo State Government / The Water and Electric Energy Department (DAEE).

1.4 Outline of Loan Agreement

Loan Amount / Loan Disbursed Amount	49,427 million yen / 49,386 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 1993 / July 1995
Terms and Conditions	
-Interest Rate	5.0% (Consultant portion: 3.25%)
-Repayment Period (Grace Period)	25 years（7 years）
-Procurement	General untied
Final Disbursement Date	July, 2006
Main Contractors (Over 1 billion yen)	Camargo Correa・Constran S/A(JV) / Carioca Christiani-Nielsen Engenharia S/A / Constran S/A Construcoes E Comercio / Construcoes E Comercio Camargo Correa S.A.・Enterpa Engenharia Ltda.・Serveng-Civilsan S.A. Empresas Associadas De Engenharia(JV) / Constructora Andrade Gutierrez S.A.・Companhia Brasileira De Projetos E Obras (JV) / Constructora Andrade Gutierrez S.A.・Mape S/A-Construcoes E Comercio (JV) / Construtora Oas Ltda.・Carioca Chistiani-Nielsen Engenharia S/A・Mendes Junior Trading E Engenharia S.A. (JV) / Construtora Oas Ltda.・Enterpa Engenharia Ltda.(JV) / Construtora Queiroz Galvao S.A.・CBPO Engenharia Ltda.・Construcap Ccps-Engenharia E Comercio S.A. （JV）/ Primav Construcoes E Comercio / Construtora Triunfo S/A *All companies are from Brazil.
Main Consultants (Over 100 million yen)	Enger Engenharia S/C Ltda.・Promon Engenharia Ltda.・Chuo Kaihatsu Corporation, Co. Ltd (JV) / Enger Engenharia S/C Ltda.・Chuo Kaihatsu Corporation, Co. Ltd (JV) / Maubertec-Engenharia E Projetos Ltda. / Projectus Consultoria S.A.・Bureau De Projetos E Consultoria Ltda. (JV) / Themag Engenharia E Gerenciamento Ltda.・Vetec Engenharia S/C Ltda.(JV) *All companies are from Brazil, except Chuo Kaihatsu Corporation, Co. Ltd (Japan).

Feasibility Study (F/S)	In 1992 / Phase 1: F/S prepared by the Bureau of Energy and Sanitary in the São Paulo State Government In 1998 / Phase 2: F/S prepared by DAEE

2. Evaluation Result (Rating: B)

2.1 Relevance (rating: a)

2.1.1. Relevance at Time of Appraisal

Beginning in 1991, the federal government of Brazil spent approximately five years establishing the National Water Resources Management System (SINGREH), a framework for policies related to water resources. SINGREH emphasizes the need to develop legal systems related to environmental issues, the importance of water resources, and so on. Meanwhile, in 1968, the São Paulo State government established the HIBRACE Plan, a multi-use water resources development plan. The objective of HIBRACE was to ensure a stable supply of water and to control flooding. In 1990, The São Paulo State established the State Plan for Water Resources to deal with the implementation of water resources policies and water resources management. As a result of population growth and industrial development in the metropolitan area, Brazil began recognizing the importance of policies related to securing water resources and water use, flood control policies, and so on.

The Tietê River running through the São Paulo metropolitan area, and the Cabuçu de Cima River had a low river discharge capacity. Therefore, when there was heavy rain, flood damage occurred on average two or three times a year. The decade of the 1990s experienced rapid urbanization, and flood damage became more severe, partly because the impervious surface of commercial and paved road expanded, and rainwater could not drain into the ground. Three water flow adjustment dams had already been constructed between 1972 and 1989 in the upper river basin of the Tietê River, which is located in the eastern part of the metropolitan area. These dams did help secure water resources and implement flood adjustment; however, as population growth and urbanization continued, there was growing awareness that future projects for a stable, clean water supply and flood control were necessary.

2.1.2. Relevance at Time of Evaluation

In 2006, the federal government of Brazil established the National Water Resources Plan (PNRH), which was built upon the aforementioned National Water Resources Management System (SINGREH). The PNRH regulates government plans related to environmental issues and water resources management until 2020. In 2004, the São Paulo State established the São Paulo Metropolitan Area Water Supply Master Plan (PDAA 2004), which focused on future water demand. In 2008, the São Paulo Metropolitan Area Water Program (PMA 2008−2014) was set up, which took the form of an upgraded Master Plan. Furthermore, at the end of 2008, the Tietê Upper River Basin Comprehensive Effluent Master Plan was established, stipulating

guidelines and plans for flood control policies for the next 10 years. Due to the concentration of the population and the industry development in São Paulo's metropolitan area, policies related to flood control and a clean water supply continue to be recognized as important.

As a result of the hydraulic improvement of the river resulting from this project, there is no flood damage from the Tietê River or the Cabuçu de Cima River at present. Furthermore, there were three dams in the upper river basin of the Tietê River prior to project; two new dams were constructed as part of this project, and they are contributing to flood adjustment functions and a clean, stable water supply[2].

Nonetheless, there are still regions around the tributary rivers of the Tietê River in the São Paulo metropolitan area (regions out of the project scope) where floods partially occur at times of heavy rain. Based on the above Master Plan, the São Paulo State government and the Executing Agency (DAEE) is preventing and mitigating flood damage by proceeding with the construction of rainwater runoff reduction facilities (flood control reservoirs) along the side of tributaries. The entities are continuing to develop anti-flood projects. Furthermore, it is forecasted that water demand in the metropolitan area will grow[3] due to further population growth[4] and urbanization, so it will be necessary to guarantee additional water resources in the future.

Regarding the above situation, this project has been highly relevant with Brazil's national policies and development needs at the times of both appraisal and ex-post evaluation.

2.2 Efficiency (rating: b)

2.2.1. Outputs

During the project implementation in June 2000, the project scope was changed[5] to incorporate a new river improvement zone into the original project. The original scope is called as "Phase 1", and the added scope is called as "Phase 2". The following table explains the comparison of planned and actual major outputs.

[2] The details are described at 2.3.1.4 Effectiveness in this report.

[3] The annual average population growth from 2000−2015 is anticipated 1.03% according to the data of the United Nations' "World Urbanization Prospects: The 2003 Revision."

[4] According to the Master Plan, the daily average amount of water supply is anticipated to rise around 43,200 m3 annually.

[5] The project period and cost were also changed. Unused budget allocations from Phase 1 implementation were transferred to the cost of Phase 2. The unused project budgets are from: 1) São Paulo State government bearing the construction cost of interconnection water canal (Phase 1) in the upper Tietê River with its own budgets (around 12 billion yen), and 2) a relatively high unit price of the construction (around 13 billion yen) was set, anticipating hyperinflation that annually exceeds 1,000% at time of the appraisal of the Phase 1.

Table 1: Comparison of Planned and Actual Major Outputs

<table>
<tr><th>Outputs</th><th>Planned
(At the Appraisal)</th><th>Actual
(At the Ex-Post Evaluation)</th></tr>
<tr><td colspan="3">Phase 1</td></tr>
<tr><td>1. Hydraulic Improvement of the Tietê River (Phase 1)</td><td>(a) From Edgard de Souza Dam to Coffer Dam (at the meeting point with Pinheiros River): 16.5km
(b) Design safety degree against flood: 1/100
(c) Design section base width: 60-100m（Design section type: Trapezoidal 1V: 2H）</td><td>=>Almost as planned
(a) and (b) are as planned
(c) Design section base width: 54-61m
(In addition, one bridge for an arch-style pedestrian passageway was constructed by local funds.)</td></tr>
<tr><td>2. Hydraulic Improvement of the Cabuçu de Cima River</td><td>(a) From the meeting point between Cabuçu de Cima River and Tietê River to Três Cruzes Bridge: 10.5km
(b) Design safety degree against flood: 1/100
(c) Design section base width: Design section type is Trapezoidal (Trapezoidal section 10-20m) and Rectangular (Rectangular section 15-30m)</td><td>=>Almost as planned
(a) 10.3km
(b) As planned
(c) As planned（But the portion of the Trapezoidal section increased）
(In addition, 7 bridges were reconstructed with local funds.）</td></tr>
<tr><td>3. Upper Tietê Water Resource Development</td><td>(a) Construction of Bitritiba Dam and Paraitinga Dam
Comparison of the planned and actual is shown below.
<table>
<tr><th colspan="2">Item</th><th>Biritiba Dam</th><th>Paraitinga Dam</th></tr>
<tr><td rowspan="2">Crest length</td><td>Planned</td><td>520m</td><td>415m</td></tr>
<tr><td>Actual</td><td>535m</td><td>425m</td></tr>
<tr><td rowspan="2">Maximum height</td><td>Planned</td><td>27m</td><td>31m</td></tr>
<tr><td>Actual</td><td>26m</td><td>28m</td></tr>
<tr><td rowspan="2">Effective storage capacity</td><td>Planned</td><td>50.0 million m^3</td><td>78.0 million m^3</td></tr>
<tr><td>Actual</td><td>34.4 million m^3</td><td>35.0 million m^3</td></tr>
<tr><td rowspan="2">Planned flood flow</td><td>Planned</td><td>400 m^3/sec.</td><td>625 m^3/sec.</td></tr>
<tr><td>Actual</td><td>190 m^3/sec.</td><td>382 m^3/sec.</td></tr>
<tr><td rowspan="2">Size of drainage basin</td><td>Planned</td><td>75k m^2</td><td>182k m^2</td></tr>
<tr><td>Actual</td><td>75k m^2</td><td>184k m^2</td></tr>
<tr><td rowspan="2">Size of submerged basin</td><td>Planned</td><td>11.0k m^2</td><td>6.9k m^2</td></tr>
<tr><td>Actual</td><td>11.4k m^2</td><td>6.6k m^2</td></tr>
</table>
=>Some designs were changed.
(b) Construction of Interconnection water canal
[Interconnection water canal</td><td>=>As planned（but construction was implemented with funds</td></tr>
</table>

	between Biritiba Dam and Tietê River] * Interconnection water canal: 3,200m, Water supply pumping station: 1 place [Interconnection water canal between Biritiba Dam and Jundiaí Dam] * Interconnection water canal: 2,900m, Water supply tunnel: 750m	from the São Paulo State government)
4.Consulting Service (Phase 1)	(a) Support for the whole management: 30M/M (b) Detail design of Tietê River/Cabuçu de Cima River: 22M/M (c) Detail design of Biritiba Dam: 33M/M (d) Detail design of Paraitinga Dam: 33M/M	=>M/M increased (a) 67M/M (b) 38M/M (c) 48M/M (d) 53M/M
Phase 2		
1. Hydraulic Improvement of the Tietê River (Phase 2)	(a) From the meeting point of Pinheiros River to Peña Dam: 24.5km (b) Design safety degree against flood: 1/100 (c) Design section base width: 50m (Design section type: Trapezoidal)	=>As planned
2. Civil Works in the Lower Tietê River Basin	(a) Heightening and improvement works of Porunduva Dike (Near the Pirapora reservoir) (b) Strengthening of Pirapora Dam (c) Improvement of connecting road (Romeiros Road): 2.9km	(a) and (c) as planned (b) Cancelled
3. Consulting Service (Phase 2)	(a) Support for the whole management: 60M/M (b) Detail design: 68M/M	=>Almost as planned (a) 66 M/M (b) 56 M/M

Source: JICA documents, Project Completion Report (PCR), Answers on questionnaires

The followings are the brief explanations of the main points of difference between the planned and actual.

Phase 1

Hydraulic Improvement of the Tietê River (Phase 1)

There is a difference in the section base width between the planned and actual. At the time of

appraisal, the section base width was planned with 100m around Edgard de Souza Dam, and the major parts of the section base width were planned mostly at 60m in other areas. As a result, there is no great difference between the planned and actual.

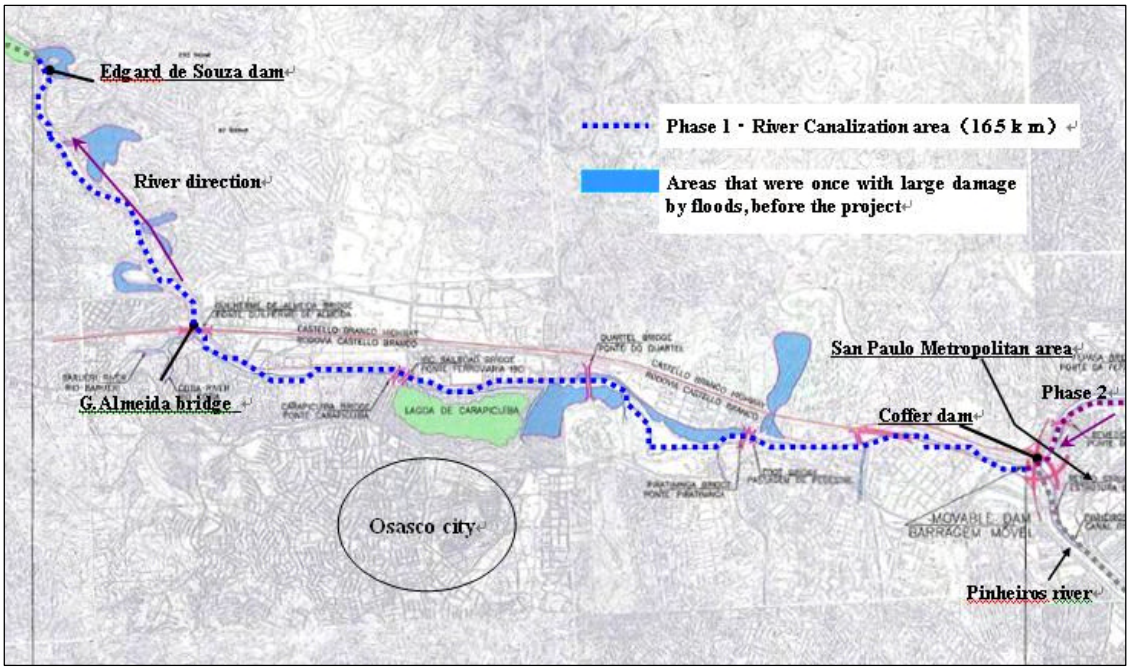
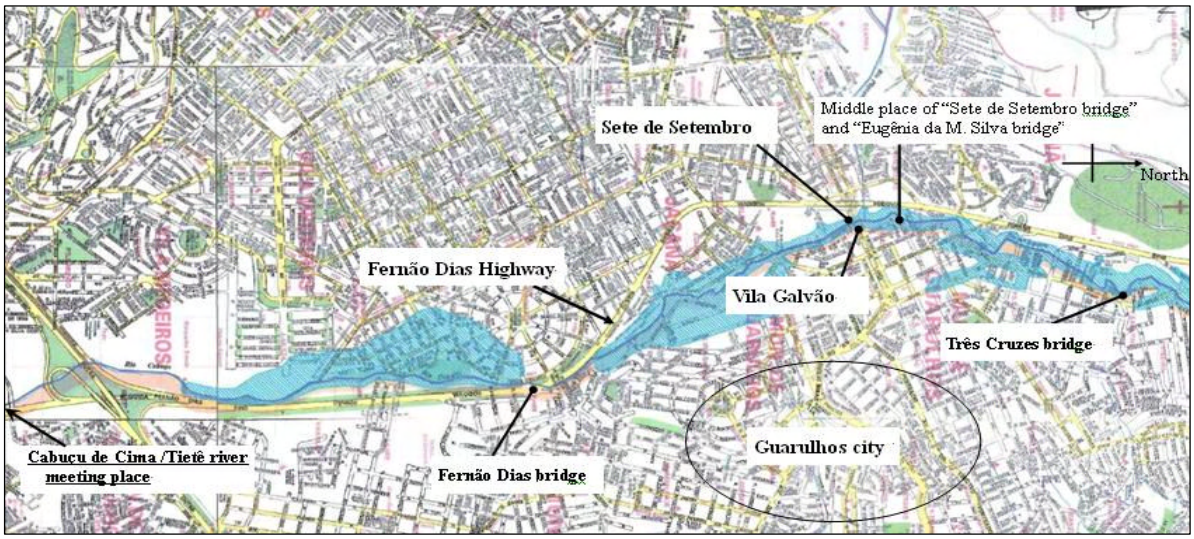


Figure 1: Project Site: Hydraulic Improvement of the Tietê River (Phase 1)

Hydraulic Improvement of the Cabuçu de Cima River

The proportion of the trapezoidal section (a design section type) increased compared to the original plan due to the design modification[6] that was deemed appropriate for project cost reasons.



[6] The detail is shown at 2.4.4 Impact "Resettlement of residents and land acquisition".

Figure 2: Project Site: Hydraulic Improvement of the Cabuçu de Cima River (the blue markings indicate actual flood damage in the past)

Upper Tietê Water Resource Development

a) Dam Construction

According to the explanation by the Executing Agency, the difference in effective storage capacity at the time of the appraisal and at the time of the ex-post evaluation was due to "the difference of the maximum height between the plan and actual,[7] leading to a disparity in the effective storage capacity." The disparities in the maximum heights and the crest lengths of the dams were due to the results of the detailed design in the project implementation stage[8].

Furthermore, the designed flood flow was different between the time of the appraisal and the time of the ex-post evaluation, because at the time of the appraisal, a discharge from a once-in-10,000-years flood was assumed; later, the design was revised to the discharge value for a once-in-a-1,000-years flood.

b) Construction of Interconnection Water Canal

The interconnection water canal and the pumping station and tunnels for water supply were constructed with funds from the São Paulo State government (the implementing agency was the Sanitation Company of the State of São Paulo [SABESP]). The reason that Japan's ODA loan funds were not used is that after the signing of the original loan agreement, water shortages became an urgent problem and water demand was tight; therefore, with JICA's approval, the construction of the interconnection water canals was commenced[9] using state government funds to act quickly to remedy the situation. At present, SABESP is operating and maintaining the facilities related to these interconnection water canals.

[7] It is about disparity in the maximum heights of the dams, of which the actual value is 28m and the planned value is 31m (3m disparity) regarding Paraitinga Dam, and which the actual value is 26m and the planned value is 27m (1m disparity) regarding Biritiba Dam.

[8] The appraisal of the dams was conducted based on the basic design of 1977 and the detailed design was planned to be conducted at the project implementation stage.

[9] Commenced in November 1997.

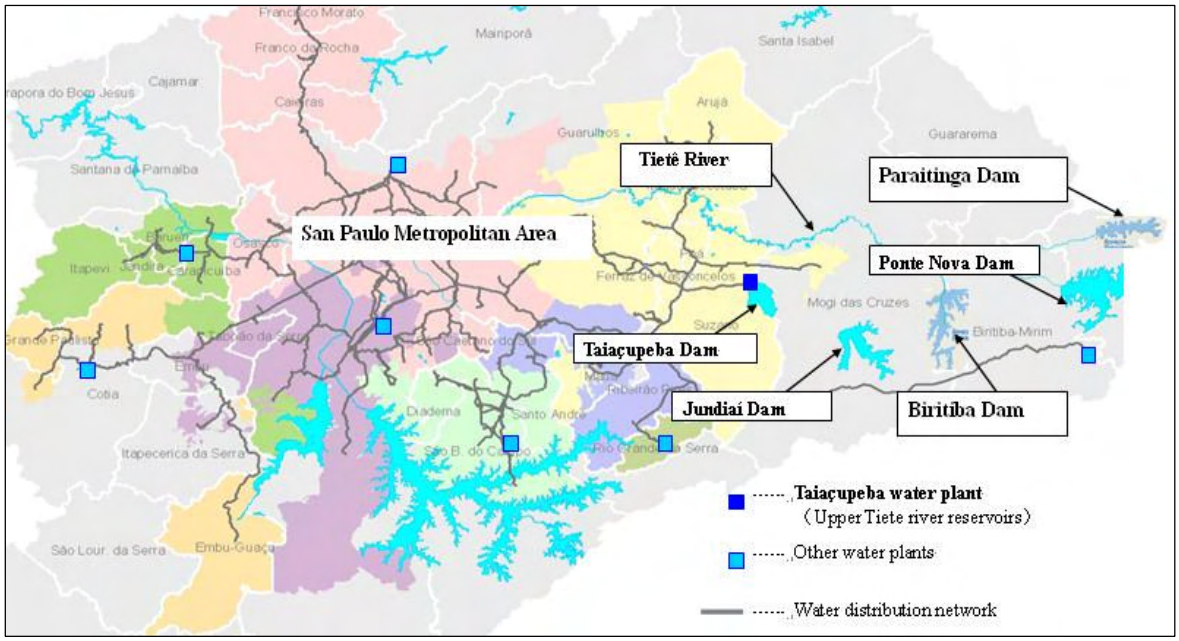


Figure 3: Project Site: Upper Tietê Water Resource Development

Consulting Service （Phase 1）

The reason the M/M increased compared to the time of appraisal was due to the extension of the project implementation period.

Phase 2

Civil Works in the Lower Tietê River Basin

In terms of the civil work of strengthening of Pirapora Dam, after the project initiation, the technical inspection about lifetime sustainability was conducted by a consultant. As a result, it was concluded that the security and lifetime sustainability were secured; therefore, with JICA's concurrence, the civil work was canceled.

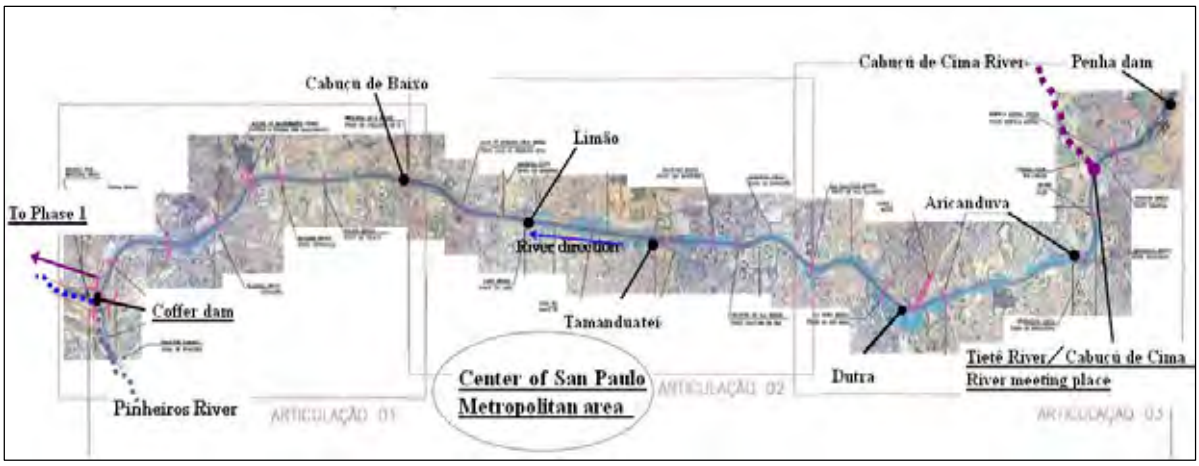


Figure 4: Project Site: Hydraulic Improvement of the Tietê River (Phase 2)

Figure 5: Pre- and Post-Views of Hydraulic Improvement of the Tietê River (Phase 2)

2.2.2 Project Period

As stated in 2.2.1, in the ex-post evaluation, the original scope is called “Phase 1” and the additional scope is called “Phase 2”. The planned project period of Phase 1 was 4 years and 11 months from July 1995 to May 2000, and the planned project period of Phase 2 was 5 years and 9 months from June 2000 to February 2006. As shown in Table 2, Phase 1 actually took eight years, from July 1995 to June 2003, 63% longer than planned. The project period of Phase 2 was the same as the plan (100% of the plan).

The delay in Phase 1 was due mainly to the delay in the Paraitinga Dam construction work, and the reasons for this delay were that the detailed design and the land acquisition procedures required substantial time and that geologically fragile areas were discovered, so it was necessary to inject cement into the soil to strengthen it. Furthermore, the delay in river improvement of the Tietê River (Phase 1) and construction of the Biritiba Dam were due to long time required for detailed designing, and the delay in the hydraulic improvement of the Cabuçu de Cima River was due to time required for land acquisition and resettlement of residents. The delay in the Civil Works in the Lower Tietê River Basin (Phase 2) was due to time required for coordination

among relevant local institutions such as the Pirapora City government as well as obtaining permission for forest clearing in the area of the connecting road to the Porunduva Dike.

Table 2: Comparison of Planned and Actual Period

Outputs	Planned	Actual
The Whole Project: Phase 1	July 1995 to May 2000 (4 years and 11 months)	July 1995 to June 2003 (8 years)
1) Hydraulic Improvement of the Tietê River (Phase 1)	February 1998 to January 2000	January 1998 to December 2000
2) Hydraulic Improvement of the Cabuçu de Cima River	July 1995 to April 1999	July 1995 to October 2001
3) Construction of Biritiba Dam	April 1998 to March 2000	December 1998 to December 2001
4) Construction of Paraitinga Dam	April 1998 to March 2000	December 1998 to June 2003
5) Consulting Service (Phase 1)	July 1997 to May 2000	July 1997 to June 2003
The Whole Project: Phase 2	June 2000 to February 2006 (5 years and 9 months)	June 2000 to February 2006 (5 years and 9 months)
1) Hydraulic Improvement of the Tietê River (Phase 2)	March 2001 to February 2006	April 2001 to February 2006
2) Civil Works in the Lower Tietê River Basin	September 2001 to February 2004	July 2003 to January 2006
3) Consulting Service (Phase 2)	June 2000 to February 2006	June 2000 to December 2005

Source: JICA documents, Project Completion Report (PCR), Answers on questionnaires

2.2.3 Project Cost

The actual project cost was below the planned cost. The planned cost was 82,379 million yen (Japan's ODA loan amount was 49,427 million), and the actual cost was 70,452 million yen (Japan's ODA loan amount was 49,386 million), which was below the planned cost (about 86% of the plan). The main reasons for cost reduction throughout both Phases 1 and 2 were the cancellation of strengthening the Pirapora Dam, the fulfillment of competitive bidding in other outputs, and the affect of fluctuations in foreign currency (Japanese yen appreciated against Brazilian Real).

The project cost was within the planned amount, but the project period exceeded the planned period; therefore the evaluation for efficiency is moderate.

2.3 Effectiveness (rating: a)

2.3.1 Effectiveness Evaluation by Operation and Effect Indicators

2.3.1.1 Discharge Capacity in the Observation Points

The following table shows the discharge capacity (flow amount maximums) in each observation point at the hydraulic river improvement zone. The "actual" at the time of ex-post evaluation, below, shows the secured capacity after the river improvement. The work of the river improvement was implemented along with the original plan, and the outputs − such as the design section base width and height of the embankment − were secured. As a result, the discharge capacity was also secured[10].

Table 3: Discharge Capacity in the Observation Points of the Hydraulic River Improvement Zone

1) Hydraulic Improvement of the Tietê River (Phase 1)

Observation Points[11]	At Time of Appraisal		Actual: At Time of Ex-Post Evaluation (Flow Amount Maximums)
	Actual Discharge Capacity	Targeted Discharge Capacity	
The meeting point of the Tietê River and the Pinheiros River	681 m^3/sec.	1,048 m^3/ sec.	1,048 m^3/ sec.
G.Almeida Bridge	717 m^3/ sec.	1,188 m^3/ sec.	1,188 m^3/ sec.
Edgard de Souza Dam	791 m^3/ sec.	1,434 m^3/ sec.	1,434 m^3/ sec.

Source: JICA documents (At the appraisal), Executing Agency documents (Actual)

2) Hydraulic Improvement of the Cabuçu de Cima River

Observation Points	At Time of Appraisal		Actual: At Time of Ex-Post Evaluation (Flow Amount Maximums)
	Actual Discharge Capacity	Targeted Discharge Capacity	
The meeting point of the Cabuçu de Cima River and the Tietê River	200 m^3/ sec.	320 m^3/ sec.	320 m^3/ sec.
Fernão Dias Bridge	100 m^3/ sec.	320 m^3/sec.	320 m^3/ sec.
Sete de Setembro Bridge	130 m^3/ sec.	297 m^3/ sec.	297 m^3/ sec.
Middle point of Sete de Setembro Bridge /Eugênia M. Silva Bridge	45 m^3/ sec.	195 m^3/ sec.	195 m^3/ sec.
Três Cruzes Bridge	25 m^3/ sec.	186 m^3/ sec.	186 m^3/ sec.

Source: JICA documents (At the appraisal), Executing Agency documents (Actual)

[10] The targeted discharge capacity value at the time of appraisal and the actual value at the time of ex-post evaluation are the same. According to the Executing Agency, as a result of securing the discharge capacity as implementing the hydraulic river improvement as planned, the capacity was secured as the targeted value.

[11] The observation points can be referenced in Figure 1 for the hydraulic river improvement of the Tietê River (Phase 1), in Figure 2 for the Cabuçu de Cima River, and in Figure 4 for the Tietê River (Phase 2).

3） Hydraulic Improvement of the Tietê River (Phase 2)

Observation Points	At Time of Appraisal		Actual: At Time of Ex-Post Evaluation (Flow Amount Maximums)
	Actual Discharge Capacity	Targeted Discharge Capacity	
Peña Dam to the End of the Cabuçu de Cima River	150 m^3/ sec.	498 m^3/ sec.	498 m^3/ sec.
End of the Cabuçu de Cima River to Aricanduva	210 m^3/ sec.	561 m^3/ sec.	561 m^3/ sec.
Aricanduva - Tamanduateí	270 m^3/ sec.	640 m^3/ sec.	640 m^3/ sec.
Tamanduateí – Cabuçu de Baixo	480 m^3/ sec.	997 m^3/ sec.	997 m^3/ sec.
Cabuçu de Baixo – Coffer Dam （around the meeting point of the Tietê River and the Pinheiros River）	640 m^3/ sec.	1,048 m^3/ sec.	1,048 m^3/ sec.

Source: Executing Agency documents (Actual)

2.3.1.2 The Highest Water Level in the Observation Points (Annual Highest Water Level)

In the hydraulic river improvement zones (Phase 1 and 2) before the project implementation, floods used to occur and cause damage in the area exceeding the Flood Danger Water Level, two or three times a year on average. Table 4 shows the recorded highest water level in each observation point of the Phase 1 and 2 zones. In the observation points after the project completion, there was only one time at which the river water level exceeded the Flood Danger Water Level in 2005 (Phase 1 zone). Although the following data cannot be concluded to be effective indicators for measuring the project effect, looking at the data of the water level, the number of exceeding the Flood Danger Water Level has diminished throughout the project implementation. Therefore, it can be assumed that flood control is working effectively. Additionally, there is no data of water level until 2006 in the Cabuçu de Cima River but, according to the Executing Agency, no flood has occurred since 2000.

Table 4: The Highest Water Level in the Observation Points（Unit: m）

Year	Observation Points (Date Shows Recorded Date)			
	Coffer Dam	Vila Galvão	Limão	Dutra
	Phase 1 (Tietê River)	Phase 1 (Cabuçu de Cima River)	Phase 2 (Tietê River: two points)	
1995	717.70 (February 2)	N/A	720.88 (February 2)	N/A
1997	719.21 (December 22)	N/A	721.22 (January 27)	N/A
2000	718.19	N/A	720.86	N/A

	(January 26)		(January 26)	
2001	716.89 (December 9)	N/A	720.75 (December 9)	N/A
2002	716.48 (November 28)	N/A	719.82 (November 28)	N/A
2003	717.14 (January 28)	N/A	720.30 (January 28)	N/A
2004	717.26 (November 29)	N/A	719.53 (April 19)	N/A
2005	719.78 (May 25)	N/A	719.76 (January 11)	N/A
2006	718.54 (March 29)	N/A	720.00 (January 4)	720.32 (November 25)
2007	718.88 (December 19)	730.34 (November 3)	720.27 (February 8)	721.11 (December 7)
2008	717.81 (January 29)	730.88 (March 13)	719.23 (January 29)	719.56 (February 22)

Source: Executing Agency Documents

Note: The double line shows the completion year of the hydraulic river improvement. The purple color shows the excess of Flood Danger Water Level (719m), and the purple color with thick frame shows the excess of the Flood Danger Water Level after the river improvement.

Reference 1: *The Water Level Standard in Each Observation Point*

Flood Danger Water Level	Flood damage can be occurred with high probability. Places where the flood may occur are prohibited to enter, and fire organizations, military, and police start their activities. Detours for cars are also prepared.
Extra Emergency Water Level	Fire organizations, military, and police are in standby. The movement of cars in the main roads is shut down by barricade. Removal of the cars is requested at the place where the flood damage was severe in the past.
Emergency Water Level	The water level rises higher than the Attention Level, and emergency notice is announced to public service entities (e.g., electric and sanitary companies), fire organizations, military, and police.
Attention Water Level	Water level becomes higher than the normal river stream, and the water level starts to be observed on a real-time base. Attention notice is announced.

Reference 2: Accumulated Precipitation at the Highest Water Level: Precipitation from the Beginning of the Rainfall to the End of the Rainfall

It cannot be said that there is a correlation between the precipitation data in Table 5 and data in Table 4 because the rainfall zone varies in the river basin and the condition of the outflow also differs. However, it can be assumed that the accumulated precipitation in the observation point was recorded high to some extent when the river water level exceeded the Flood Danger Water Level.

Table 5. Accumulated Precipitation at the Highest Water Level (Table 4) （Unit: mm）

Year	Accumulated Precipitation at the Observation Points (*date below shows its recorded date)			
	Coffer Dam	Vila Galvão	Limão	Dutra
	Phase 1 (Tietê River)	Phase 1 (Cabuçu de Cima River)	Phase 2 (Tietê River: Two Points)	
1995	79.30 (February 2)	N/A	**70.30** (February 2)	N/A
1997	**150.40** (December 21 to 23)	N/A	N/A	N/A
2000	13.70 (January 26)	N/A	**65.00** (January 26)	N/A
2001	54.60 (December 9)	N/A	80.80 (December 9)	N/A
2002	6.80 (November 28)	N/A	0 (November 28)	N/A
2003	63.90 (January 28)	N/A	32.40 (January 28)	N/A
2004	117.30 (November 29)	N/A	21.80 (April 19)	N/A
2005	**105.20** (May 25)	N/A	44.20 (January 11)	N/A
2006	100.40 (March 29)	N/A	N/A	N/A
2007	47.30 (December 19)	83.00 (November 3)	51.00 (February 8)	N/A
2008	45.00 (January 29)	72.40 (March 13)	45.00 (January 29)	N/A

Source: Executing Agency Documents

Note: The purple color shows the excess of Flood Danger Water Level (719m), and the purple color with thick frame shows the excess of the Flood Danger Water Level after the river improvement.

2.3.1.3 Flood Frequency, Inundated Area, and Number of Inundated Buildings (Damaged Buildings)

The following table shows the data recorded by the Executing Agency before the project implementation on the anticipated flood damage[12] and actual maximum flood damage. According to the Executing Agency, before the project implementation in the Tietê River Phases 1 and 2 zones, floods actually occurred two or three times a year on average, and on the Cabuçu de Cima River they occurred six to ten times a year on average. However, the data compiled in the Executing Agency about actual flood damage – such as the inundated area and the number of inundated buildings, etc. – was deficient, so data on flood damage was created using estimates

[12] It is not the actual value but the anticipated value of flood damage that can be occurred periodically before the project implementation.

such as the following, with reference to the various conditions, statistical data, and so on, related to flood damage. In this way, indicators and data on project effectiveness and flood damage were not managed thoroughly in the Executing Agency, which resulted in the difficulty to measure project effectiveness (quantitative effects) in the ex-post evaluation. However, according to the Executing Agency and the local interview surveys, it has been confirmed that since the project completion, no flood damage has occurred in the hydraulic improvement zones of the Tietê River and the Cabuçu de Cima River.

Table 6: Data of Anticipated Damage and Actual Maximum Damage before Project Implementation

Indicators (Anticipated Damage)	Tietê River (Phase 1 Zone)		Tietê River (Phase 2 Zone)		Cabuçu de Cima River (Phase 1 Zone)	
	Periodic Flood	Flood February 1, 1983[a]	Periodic Flood	Flood February 1, 1983[a]	Periodic Flood	Flood January 15, 1991[a]
Inundated Area	53,150 m^2	6,341,000 m^2	505,000 m^2	10,568,000 m^2	N/A[b]	350,000 m^2
Number of Inundated Houses	324	2,432	624	11,463		3,000
Number of Inundated Office Buildings	29	219	88	1,662		N/A
Total Inundated Commercial Areas	5,294 m^2	63,160 m^2	129,331 m^2	878,201 m^2		N/A
Total Inundated Industrial Areas	31,093 m^2	342,097 m^2	116,857 m^2	930,512 m^2		N/A

Source: Executing Agency documents

[a] "Flood occurred February 1, 1983" and "Flood occurred January 15, 1991" are the data of maximum damage in the last 30 years.

[b] The periodic flood damage data was not recorded.

As shown in Table 4, in one of the Phase 1 zones, a water level in excess of the Flood Danger Water Level was recorded on May 25, 2005. According to the Executing Agency, the elevation of the land surrounding the river is higher than the Coffer Dam's observation point (measurement point), so that even when the discharge from the river reached the Flood Danger Water Level at a time of heavy rain, the water did not go as far as the surrounding land areas, so no damage occurred. At other observation points in Table 4, based on the measured data, the Flood Danger Water Level did not exceed after the hydraulic river improvement. Therefore,

flood damage from the improvement zone of this project was reduced to zero, so we can judge that the initial objective (the reduction of flood damage) was achieved.

On the other hand, around the tributaries of the Tietê River and the Cabuçu de Cima River, there are locations in which floods occur at times of heavy rain, causing damage to surrounding areas. The major reason for this is that effluent treatment is not being fully carried out due to rapid urbanization from the expansion of commercial and residential areas. The Executing Agency is cooperating with local governments in an attempt to alleviate flood damage by constructing rainwater runoff reduction facilities (flood control reservoirs) along the banks of the rivers (tributaries); however, at the current time, they have not been able to prevent all flood damage in the tributaries. Nonetheless, it is expected that future flood damage will be reduced further with the addition[13] of more facilities.

Figure 6 : Flood Damage in February 1983

Figure 7: Rainwater Runoff Reduction Facilities (Flood Control Reservoirs)

Reference: *Flood Damage for Residents in the São Paulo Metropolitan Area*

The following table shows the data on residents suffering from floods in the rainy season (in normal years the four-month period from December to March). The figures show the number of victims in the São Paulo metropolitan area overall until 2003−2004 and in each municipality from 2004−2005 onwards (examples: São Paulo City → the Tietê River Phase 2 area, Guarulhos City → the Cabuçu de Cima River area, Osasco City → the Tietê River Phase 1 area). When referring to this data, it is important to note that data indicates "flood damage that occurred in the areas including all of the tributaries". Therefore, there was no flood damage at all from the main Tietê River and the Cabuçu de Cima River.

No major changes can be seen in the number of injuries or fatalities; however, over the last few years, the number of people who have lost their homes has been lower than previously. Since the hydraulic river improvement has been completed and the aforementioned construction of rainwater runoff reduction facilities along the banks of the rivers (tributaries) is continuing, it

[13] As of December 2008, there are 42 flood control reservoirs in the São Paulo metropolitan area, and four new facilities are under construction. The largest of the flood control reservoirs has a maximum capacity of 800,000m^3 (approximately two-thirds of the size of Tokyo Dome).

is assumed that in the future flood damage will be reduced even further in the São Paulo metropolitan area.

Table 7: Flood Damage for Residents in the São Paulo Metropolitan Area

Year	Areas	Injuries	Fatalities	People who Lost their Homes
2001−02	The whole São Paulo metropolitan area	28	7	365
2002−03	The whole São Paulo metropolitan area	33	11	714
2003−04	The whole São Paulo metropolitan area	16	1	482
2004−05	São Paulo City	7	5	30
	Guarulhos City	8	2	40
	Osasco City	0	0	120
2005−06	São Paulo City	12	4	261
	Guarulhos City	1	6	46
	Osasco City	12	1	235
2006−07	São Paulo City	4	1	14
	Guarulhos City	1	2	11
	Osasco City	0	1	0
2007−08	São Paulo City	11	6	0
	Guarulhos City	4	1	44
	Osasco City	6	0	67
2008−09	São Paulo City	20	4	0
	Guarulhos City	1	1	18
	Osasco City	0	2	0

Source: Defesa Civil S.P.

2.3.1.4 Population Served, Percentage of Population Served and Amount of Water Supply （Project Effects by Upper Tietê Water Resource Development）

The Water Supply System in the Upper Tietê River Basin (water amount adjustment using storage dams) has functions not only for flood control but also for supplying clean water. In short, this adjustment system has a function that enables it to control water amount, to some extent, to prevent flood damage at times of heavy rain in the São Paulo metropolitan area while at the same time being used as a valuable source of clean water. The Biritiba Dam and the Paraitinga Dam constructed in this project, in combination with the existing three storage dams (Ponte Nova, Taiaçupeba and Jundiaí for a total of five dams), constitute the Water Supply System in the Upper Tietê River Basin. Water is delivered to the Taiaspeba Dam via the interconnection water canals and pumping stations, and then it is purified and treated at the

adjacent water treatment plant and supplied to the São Paulo metropolitan area. The water is largely used for drinking. Currently, the total amount of purified and treated water delivered from these five storage dams is approximately 10m^3/second (of this, a total of about 2.5m^3/second is the amount of purified and treated water from the Biritiba Dam and Paraitinga Dam). In the near future, it is planned to enhance the facilities and equipment functions of the Taiaspeba water treatment plant to supply water at approximately 15m^3/second.

As shown in Table 8 below, the population served and the amount of average daily water supply in the São Paulo metropolitan area are increasing year by year. The reason that the amount of average daily water supply declined slightly in 2007−2008 is that SABESP implemented a program related to the appropriate use and loss control of water. The amount of purified and treated water within the São Paulo metropolitan area overall is currently approximately 68m^3/second. As stated above, the amount of purified and treated water from the Biritiba Dam and the Paraitinga Dam is not large, but both dams are considered valuable water resources for a stable water supply to the metropolitan area.

Table 8: Population Served, Percentage of Population Served and Amount of Water Supply in the São Paulo Metropolitan Area

Item	Estimated Value before Project Implementation			Actual Value				
	1990	1995	2000	2004	2005	2006	2007	2008
Population Served (Unit: thousand people)	14,613	16,283	18,150	18,280	18,316	18,465	18,637	18,910
Supply Rate (Percentage of Population Served) (Unit: %)	91	92	94	96	96	96	96	96
Amount of the Average Daily Water Supply (Unit: thousand m^3/day)	3,818	4,361	5,044	5,565	5,685	5,810	5,763	5,754

Source: JICA documents, SABESP

2.3.2 Recalculation of Economic Internal Rate of Return (EIRR)

In this ex-post evaluation study, it was not possible to recalculate the Internal Rate of Return with the same condition as time of the appraisal, because the calculation base at time of the appraisal was unclear and the value itself was only for the Phase 1 project. The Executing Agency prepared a report regarding the economic evaluation of this project in May 2001, including a portion of Phase 2. Then, the Economic Internal Rate of Return (EIRR) was calculated as 10.97 % in the report. In this ex-post evaluation study, when EIRR was

recalculated applying the same condition,[14] the rate was 8.49%. The reason the rate was lower than the estimation is that the actual maintenance cost (actual amount of 2006−2009) increased compared to the estimated maintenance cost[15], which was calculated in May 2001.

2.3.3 Implementation of Beneficiary Survey (Qualitative Effects)

In this ex-post evaluation study, a beneficiary survey (questionnaire survey) targeted residents and those who are engaged in commercial activities was conducted[16], choosing three points which were once with large damage by flood before the project implementation. The following figures show the results.

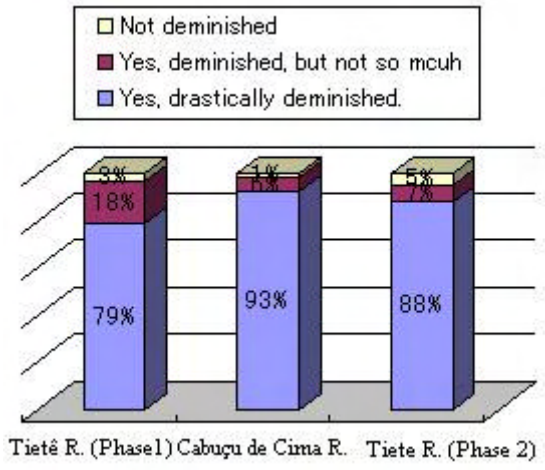


Figure 8: Whether the flood frequency has decreased compared to before the river improvement

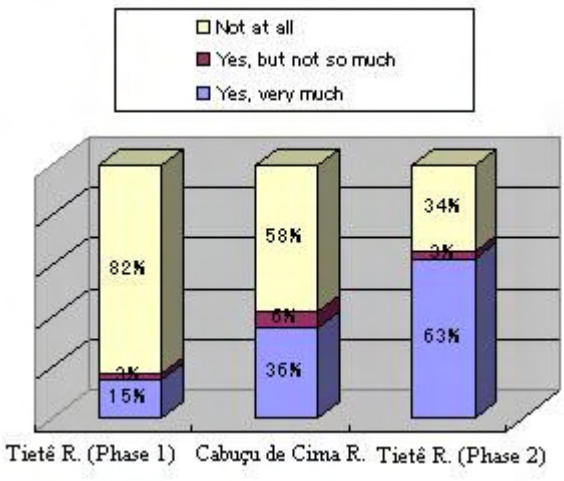


Figure 9: Whether there was flood damage (human/economic) before the river improvement

[14] In calculation of EIRR, construction costs and operation & maintenance costs were included in costs, and decrease of flood damage on buildings in surrounding residential, commerce, and industrial areas, and decrease in transport cost were included in benefits.
[15] Sufficient amount of operation & maintenance costs were not estimated, when calculating before the project.
[16] The total sample is 200, which consist of 62 samples from Tietê River Phase 1 (Osasco City), 70 samples from Cabuçu de Cima River (Guarulhos City), and 68 samples from Tietê River Phase 2 (São Paulo City).

Table 9: Transition of Damage Degree in the Pre- and Post-Hydraulic River Improvement

Type of Damage	Before the River Improvement	After the River Improvement
Flowing Dirt to Buildings	Yes 99% No 1%	Yes 9% No 91%
Damage to Furniture and Equipment	Yes 86% No 14%	Yes 5% No 95%
Damage to Buildings	Yes 48% No 52%	Yes 4% No 96%
Injuries by Flood	Yes 16% No 84%	Yes 1% No 99%
Damage to Lifelines (e.g., electricity and water supply)	Yes 35% No 65%	Yes 4% No 96%
Damage to Roads and Transports	Yes 62% No 38%	Yes 8% No 92%

Source: Beneficiary survey result: Question for those who answered "Yes" in Figure 9, three areas total

As shown in Figure 8, most residents realize that there are no longer floods in the hydraulic river improvement zone of this project. The reason that there are some respondents who answered "not diminished" seems to be due to the fact that flood still occurs（Referring to 2.3.1.3）in the tributaries of the Tietê River and the Cabuçu de Cima River.

As shown in Figure 9, flood damage was especially severe in the Phase 2 zones before the hydraulic river improvement. The residential and commercial areas in the Phase 2 zones are more crowded than the Phase 1 zones, and it seems that the damage was relatively large when floods occurred. It is evident that there has been a drastic change between the pre- and post-river improvement, looking at both the situation of human / economic damage and the transition of the damage degree.

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

2.4 Impact

2.4.1 Improvement of Life Environment in the São Paulo Metropolitan Area

The result of beneficiary survey[17] regarding improvement of life environment of the residents by the flood mitigation was as follows. Judging the overall tendency, it is inferred that this project has contributed highly to the improvement of life environment for those living and working in São Paulo metropolitan area. The number of the beneficiaries of this project is assumed to be around 20 million people.

[17] A questionnaire survey was conducted in the same way as the beneficiary survey of 2.3.3 Effectiveness (3 areas and 200 samples).

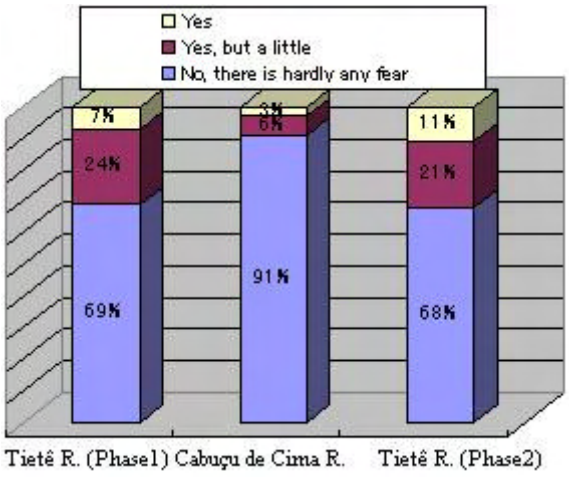


Figure 10: Whether there is fear of flood after the river improvement

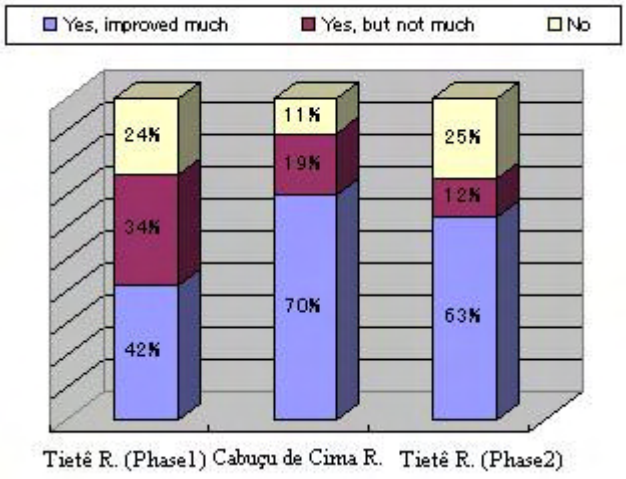


Figure 11: Whether unsanitary conditions were improved after the river improvement

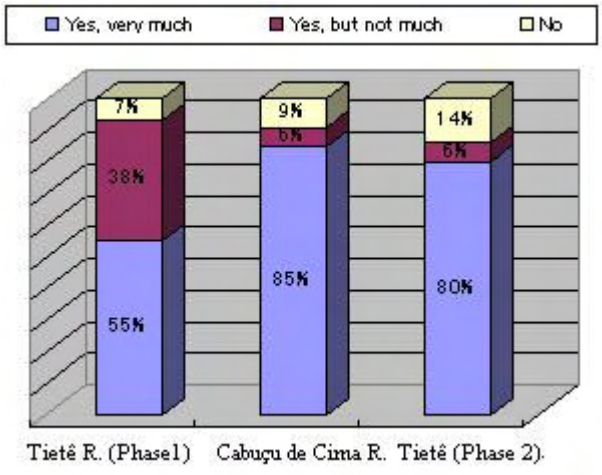


Figure 12: Do you think the sanitary improvement (Figure 11) is due to the river improvement and flood control?

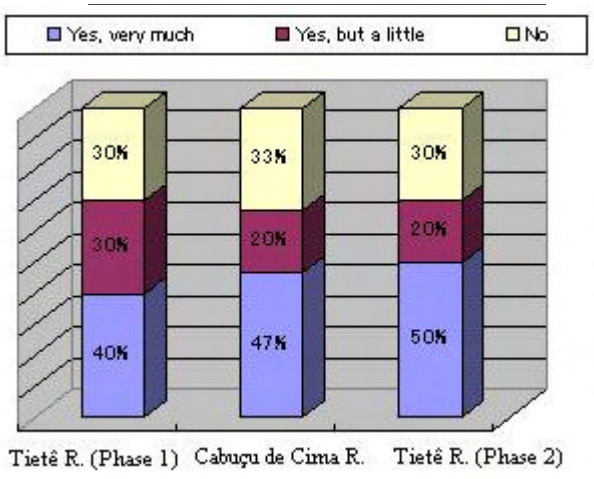


Figure 13: Do you think there has been a positive influence on commercial activities after the river improvement?

The ex-post evaluation study also surveyed whether any changes have occurred regarding diseases in pre- and post-river improvement, and the answers are shown in Table 10 (including multiple answers). The percentage of those who answered “None” increased greatly after the hydraulic river improvement. In addition, regarding leptospirosis and diarrhea, the number of answers in the Table 10 after the hydraulic river improvement has decreased. Therefore, it is assumed that this project has contributed to the improvement of health aspect of the residents as flood damage was alleviated.

Table 10: Improvement of Infectious Diseases, etc. (Unit: people)

Disease	Before the Hydraulic River Improvement	After the Hydraulic River Improvement
Infectious Disease (Leptospirosis[18])	68	8
Diarrhea	56	20
Parasitic or Worm Diseases	30	6
Hepatitis	14	2
Dengue Fever	12	10
Respiratory Disease	4	4
Others	10	8
Uncertain (No Answer)	8	12
None (Not Infected)	70	**140**

Source: Beneficiary survey results（3 areas total, sample size: 200）

2.4.2 Impact on Industrial Development (Regional Economic Development)

Table 11 shows the Gross Regional Domestic Product (GRDP) over the past few years in São Paulo City, which has been generally increasing. It cannot be concluded that the effects of this project have directly contributed to the economic growth, but it can be inferred that economic and social activities have expanded due to the alleviation of flood damage. In particular, along the hydraulic river improvement of the Tietê River Phase 2 zone, there is a trunk road called the Marginal Tietê with a traffic volume of approximately 900,000 to 1 million vehicles a day along large commercial and industrial areas, and it is assumed that the river improvement had an economic impact. Furthermore, the Marginal Tietê is also the access road to the Guarulhos International Airport (São Paulo International Airport). In interview surveys, some respondents answered they no longer need to worry about being late to catch a flight, because there was no danger of flooding. Furthermore, the Tietê Bus Terminal, the largest bus terminal in South America, is also located along the Tietê River Phase 2 zone, and it has been acknowledged that there is no longer any danger of floods disrupting the operation of the terminal or the buses, which has had a positive social and economic impact. Therefore, it can be concluded that this project, which had the objective of flood control, is supporting the economic and industrial activities of São Paulo.

[18] Leptospirosis infects from a wild rat, etc. to the human. It is an acute febrile illness with symptoms such as chills, fever, headache, worthless feeling throughout the whole body, and bulbar conjunctivas. It is assumed that the danger of infection rises after the flood. There is no human-to-human infection.

Table 11: Gross Regional Domestic Product in São Paulo City (Unit: Million real)

Year	GRDP	Year	GRDP
2002	178,953	2005	261,456
2003	209,555	2006	282,852
2004	225,170	2007	N/A

Source: Bureau of Statistics and Data (SEADE)

2.4.3 Impact on Natural Environment

2.4.3.1 The Upper Tietê River Basin（Biritiba Dam and Paraitinga Dam）

No problem was seen with respect to influence on the natural environment by implementation of this project. Apart from that, the Executing Agency conducts activities such as forestation for soil protection around reservoir dams in the Upper Tietê River Basin.

The following is the data on water quality of the both dams. According to the Executing Agency and SABESP, which collects the data, the water quality of the Upper Tietê River Basin including the dams is acceptable[19].

Table 12: Water Quality of Biritiba Dam and Paraitinga Dam

Item	Biritiba Dam	Paraitinga Dam
pH	5.81～6.47	5.94～6.26
COD (mg/l)	0.77～1.70	1.85～3.13
Temperature（℃）	19.60～23.80	22.20～22.70
Cloudiness (NTU)	3.15～6.26	6.34～9.34

Source: Executing Agency documents（2006）

Note: The above data shows both the minimum and the maximum value, because data on these items is collected at several observation points.

The Environmental Impact Assessment (EIA) regarding this project was conducted in Oct. 1997 for Phase 1 and in September 1998 for Phase 2.

Figure 14: Environmental Awareness Activity by Navigating a Workshop Boat

2.4.3.2 Environmental Activities of the Executing Agency

The water quality of the Tietê River and the Cabuçu de Cima River is poor, due to the fact that untreated sewage and waste flow into the rivers. The Executing

[19] As mentioned, the water from Biritiba Dam and Paraitinga Dam is transferred to the water treatment plant adjacent to Taiaçupeba reservoir. The water is purified and treated, and then supplied to São Paulo metropolitan area. Although the water quality standard before the purification and treatment is unknown, the standard after the purification and treatment is set at 6.5−9.0 as of pH and less than 5.0 of cloudiness, according to water quality standard of SABESP. As comments of SABESP, the pH and cloudiness in the table is near or less disparity to the water quality after the purification and treatment, which has no problem.

Agency conducts education activities on environmental issues by navigating a workshop boat in the Tietê River Phase 2 zone.

As part of the activity, elementary and secondary school students and the residents participate in seminars on sanitary awareness and issues of waste disposal into rivers on the workshop boat. These activities are recognized to be a good opportunity to raise environmental consciousness among residents in a large city such as São Paulo.

2.4.4 Resettlement of Residents and Land Acquisition

a) The Cabuçu de Cima River[20]

The construction work for river improvement of the Cabuçu de Cima River was originally planned with resettlement of residents (legal residents: 750, illegal residents: 5,170) and land acquisition (about 25 ha). In practice, 183 legal residents were subject to the resettlement, and compensation was paid to them by the State government through legal procedures. In addition, public housing was provided as resettlement compensation for 342 illegal households. Apart from that, the area subject to land acquisition was around 50 ha. Resettlement and land acquisition were implemented based on the Resettlement Program by the Habitat Bureau of the São Paulo State Government and by the City Government. No problems occurred from the implementation.

Table 13: Resettlement of Residents and Land Acquisition along the Cabuçu de Cima River

		Planned	Actual
Resettlement of Residents	Legal Residents	750 people	183 people
	Illegal Residents	5,170 people	342 households [a]
Land Acquisition	Acquired Areas	About 25ha	About 50ha

Source: JICA documents, Answers from the Executing Agency

[a] The accurate number of the people is unknown.

The reason that there was a huge difference between the plan for the resettlement of residents and the actual outcome is that the road development plan in the vicinity of the Cabuçu de Cima River (Fernão Dias Road Construction Plan[21]) was implemented in 1995−1997 with the budget of the federal government and, as a part of this, the large portion of resettlement was implemented.

In other words, many of the residents who needed to be resettled in this project were the same as those who were subject to resettlement under the road development plan that

[20] The hydraulic river improvement of Tietê River Phase 2 zone was not subject to the resettlement and land acquisition.

[21] Road expansion was implemented.

proceeded before this project, and as a result, fewer residents needed to be resettled under this project than initially planned. The public housing (apartments) provided to the households of illegal residents generally had a good reputation.

The initial plan was to acquire approximately 25ha of land, but in practice approximately 50ha of land was acquired. According to the Executing Agency, the area subject to land acquisition increased because the initial plan was to carry out river improvement using rectangular concrete (high cost), but in 1995, the plan was revised and under the new plan, rectangular concrete was adopted only in areas with a high population density, with trapezoid concrete (low cost) being adopted in many zones instead.

Figure 15: Cross-sections of the Cabuçu de Cima River. The near side is rectangular concrete, and the

b) Biritiba Dam and Paraitinga Dam

The 147 legal residents living around Biritiba Dam and the 94 legal residents living around Paraitinga Dam were subject to resettlement. Although the negotiation and compensation process with the former is almost finishing, there are still legal residents[22] in the process of negotiation with respect to the latter. The reason it takes a long time for the negotiation and procedure is that it requires time to coordinate among the stakeholders, as courts intervene in the process regarding land acquisition and the compensation process. According to the Executing Agency, the negotiation and procedure about the resettlement of Paraitinga Dam are advancing gradually and currently there are no major problems.

2.5 Sustainability (rating: b)

2.5.1 Executing Agencies

2.5.1.1 Institutional Structure for Operation and Maintenance

The Executing Agency（DAEE）is the public organization under the São Paulo State government. There are three bureaus under the superintendency: the Bureau of Water Resources Management and Assistance to Municipalities, the Bureau of Metropolitan Area Works and Technical Support, and the Bureau of Operation Support. They implement the river improvement and the management in the São Paulo State. Total number of employees was 1,252[23] in December 2008. Though the employees numbered 3,432 before the project implementation in 1995, the number decreased after the project initiation through introduction of early retirement program and new employment restraints. According to the Executing Agency,

[22] The negotiation is with respect to the compensation amount.

[23] However, the official number of employees is now 4,885, including vacant posts, as which is the way of indicating the number of employees in the public organization. The official number of the employees before the project implementation including the vacant posts was 6,646.

there was no obstacle to organizational management along with reduction of personnel.

The followings are the descriptions of the sections in charge of operation and maintenance (O&M) and its system, regarding each output.

1）Operation and maintenance system of the hydraulic river improvement zone of the Tietê River (the zones of Phase 1 and 2)

The Project Office of the Tietê River（Unidade de Gerenciamento do Projeto Tietê: UGP）is in charge of the O&M. The UGP is under the above mentioned Bureau of Metropolitan Area Works and Technical Support. The employees are 32, of which 5 are administration staff and the other 27 are technical staff.

2）Operation and maintenance system of the hydraulic river improvement zone (the Cabuçu de Cima River)

The Engineering and Construction Department（Directoria de Engenharia e Obras: DEO）is in charge of the O&M. The DEO is also under the Bureau of Metropolitan Area Works and Technical Support. There are 64 employees, 10 of which are administration staff and the other 54 are technical staff.

3）Operation and maintenance system of Biritiba Dam and Paraitinga Dam

The Upper Tietê Basin Office（Directoria da Bacia do Alto Tietê: BAT）is in charge of the O&M. The BAT is under the above mentioned Bureau of Water Resources Management and Assistance to Municipalities. The employees are 203, of which 31 are administration staff and the other 172 are technical staff. The staff of local administration offices located near the Paraitinga Dam are engaged in the management of local facilities and the periodical inspection.

As of April 2009, the BAT is in charge of the O&M of Biritiba Dam and Paraitinga Dam, but the Executing Agency started a process transferring the responsibility of O&M to SABESP[24], because the dams have functions of water supply. As the result of an interview with the SABESP, the O&M system can be judged as sufficient. Therefore, there is no problem for the O&M of the dam facilities[25].

As above, no problems are detected for securing the number of employees in the Executing agency, and it can be judged that there is no problem about operation and maintenance system of this project.

[24] SABESP consists of five departments; General Administration Department, Financial Department, Technical and Planning Department, Metropolitan Area Department, and Regional Department under the president. The organization is implementing water supply and sewage projects for 367 municipalities in the São Paulo State. The number of employees at the end of 2007 was 17,300.

[25] At present, SABESP is implementing a JICA loan project “Sanitation Improvement Project of Baixada Santista Metropolitan Region”, whose objective is to improve water quality in the coast area of the São Paulo State by development of sewage facilities and environmental monitoring system; thereby contribute to the improvement of life environment of the residents. The project started in August 2004. In addition, the organization is also implementing a JICA technical cooperation project “Control Project of Unaccounted-For Water”, whose objective is to decrease the unaccounted-for-water in the State. The project started in March 2007.

2.5.1.2 Technical Capacity for Operation and Maintenance

The Organizational Development Department（Diretoria de Desenvolvimento Organizational: DDO） under the Bureau of Operation Support is in charge of the training courses and programs for the employees, and the work training program for executive and technical staff is being planned and conducted. In 2007, 35 training programs were conducted, and 107 employees participated in these programs. In addition, there are a number of experienced employees in each section, and On-the-Job Training (OJT) is also being conducted on necessary bases.

Regarding the above, the technical level of operation and maintenance in the Executing Agency is being secured.

2.5.1.3 Financial Status for Operation and Maintenance

The following table shows data of O&M costs of each output (the hydraulic river improvement zones of the Tietê River and the Cabuçu de Cima River, Biritiba Dam, Paraitinga Dam) in the last three years. The upper column shows the actual disbursed O&M costs from the State Government to the Executing Agency, and the lower column shows the requested budget from the Executing Agency to the State Government. Prior to 2008, the São Paulo State government did not allocate enough amount of budget against the Executing Agency's request, which seems to have been some obstacles for O&M works, but the budget of O&M of each output tend to increase year by year.

Table 14: O&M Costs of Each Output (Unit: Real)

Outputs	2006	2007	2008
Tietê River	(Actual) 4,291,174	(Actual) 9,112,445	(Actual) 18,134,508
	(Requested) 25,581,127	(Requested) 15,323,500	(Requested) 25,581,127
Cabuçu de Cima River	(Actual) 0	(Actual) 1,660,000	(Actual) 5,456,583
	(Requested) 6,000,000	(Requested) 6,000,000	(Requested) 6,000,000
Biritiba Dam	(Actual) 0	(Actual) 0	(Actual) 65,505
	(Requested) 0	(Requested) 0	(Requested) 65,505
Paraitinga Dam	(Actual) 0	(Actual) 0	(Actual) 63,488
	(Requested) 0	(Requested) 0	(Requested) 63,488

Source: Executing Agency Documents

The O&M costs for the Tietê River (the actual amounts) are increasing every year. Regarding the O&M costs for the Cabuçu de Cima River, a budget close to the requested amount were finally allocated in 2008. No maintenance has been carried out for the Biritiba Dam and the Paraitinga Dam since their completion; however, in 2008, a budget was allocated for monitoring personnel's labor costs as requested. As stated above, O&M of these dams in the future is transferred to SABESP; and SABESP claims to carry out O&M with a secured budget after transfer of the facilities.

The Executing Agency is aware of the fact that O&M budget is hardly allocated as requested from the state government, and thus it tends to request smaller amount.

2.5.2 Conditions of Operation and Maintenance

The following are the descriptions of the condition of O&M of each output.

1）O&M of the hydraulic river improvement zone of the Tietê River（Phase 1 and 2)

River maintenance is being implemented regularly. Cleaning and weeding of the base of the dikes and riverbeds in the improvement zone, O&M of the river discharge control dams (the Peña Dam and so on) and the discharge gates are being implemented based on the maintenance plan of the Executing Agency. The actual maintenance is being carried out by a subcontracted private company under the supervision of the Executing Agency. Furthermore, there are several radar posts set up along the main Tietê River to measure the amount of rainfall and floodwater levels, and hence real time monitoring of the river is being implemented, and there is no problem with the operational status of the equipment. Dredging boats and berths (maintenance stations are in 3 locations) are in place.

Meanwhile, over time, silt builds up on the riverbed of the Tietê River, and in some places, this is causing corrosion and sediment contamination (buildup of sludge, etc.). According to the results of a research survey that was commissioned to a local research institution by the Executing Agency, it is expected that approximately 400,000m^3 of silt builds up in each of the Tietê River Phase 1 and 2 zones every year. As a result, there is a possibility that the silt will result in waterweed and algae growth in the river, resulting in a decline in its discharge capacity. According to the Executing Agency, the O&M budget is insufficient, so adequate removal work and disposal has not been possible; as a result, there are now approximately 2,500,000m^3 of silt that has built up throughout the river improvement zone. Given this situation, the Executing Agency is carrying out silt removal by outsourcing the work to a private company within the O&M budget[26].

[26] In this fiscal year, the work of removing approximately 400,000m^3 of silt has been commissioned to a private company, and the work is currently underway.

Figure 16: Work of Periodical Maintenance

Figure 17: Work of Silt Removal

2） O&M of the hydraulic river improvement zone of the Cabuçu de Cima River

Regular maintenance is not being carried out. The O&M budget is insufficient, so only remedial maintenance is carried out when a problem occurs. As same as the Tietê River, silt builds up on the riverbed of the Cabuçu de Cima River over time, and in some places, corrosion and sediment contamination is occurring. In some areas, the buildup of silt is already hindering water flow. It is considered that every year, approximately 100,000m^3 of silt builds up in this river overall. The Executing Agency stated that since the completion of the river improvement work, approximately 600,000m^3 of silt has built up. According to the Executing Agency, in 2008, it removed approximately 100,000m^3 of silt from the riverbed. Furthermore, it plans to remove a like volume of silt during 2009. The silt in this river overall builds up by approximately 100,000m^3 each year, so the Executing Agency plans to remove as much as possible while taking into consideration of its O&M budget.

There is also a radar post set up and operating on the Cabuçu de Cima River to measure the amount of rainfall and floodwater levels. However, the Cabuçu de Cima River is smaller than the Tietê River, so there is only one radar post on the river.

3） O&M of Biritiba Dam and Paraitinga Dam

Regular maintenance is not carried out on either dam, apart from the O&M budget allocated in 2008 as a labor cost for monitoring personnel. At present, there is no major problem due to lack of maintenance work, including the banking sand in the dams. As stated previously, the responsibility of the O&M of both dams will be transferred to SABESP. SABESP claims to carry out proper maintenance with diligence.

There is one radar post for each dam to measure the amount of rainfall and floodwater levels, and there have been no problems about their O&M conditions.

Figure 18: Paraitinga Dam

Figure 19: Biritiba Dam

No major problems have been observed in the capacity of the Executing Agency nor its operation and maintenance system; however, considering there is not sufficient O&M budget and some maintenance works are not able to be conducted, sustainability of this project is fair.

3 Conclusion, Lessons Learned, and Recommendations

3.1 Conclusion

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

3.2 Lessons Learned

Indicators and data regarding the project effect and flood damage are not always managed thoroughly, partly because the effect measurement of flood mitigation projects is not easy. To measure the project effect, it is necessary to obtain data, especially quantitative indicators including that of flood damage before the project implementation. The Executing Agency should consistently manage the indicators and data regarding project effects from the project planning stage to the evaluation/monitoring stage, with support from aid agencies.

3.3 Recommendations

As stated above, the budgets for the operation and maintenance are insufficient for removal and disposal of the silt buildup in the Tietê River and the Cabuçu de Cima River. After the project completion, there were no more floods from either of the two rivers; however, if progress is not made on the removal of the silt building up in the rivers every year, at times of heavy rain when the amount of the rivers increases, the silt could be a factor in causing a flood. The Executing Agency should make an appropriate plan for the removal of the silt and put in place a structure for removal and disposal efforts. Further, the government of the State of São Paulo should allocate sufficient budget to the Executing Agency for the operation and maintenance costs of the river facilities and endeavor to reduce the risk of floods.

Comparison of Original and Actual Scope

Items	Planned	Actual
(1) Outputs	Hydraulic Improvement of the Tietê River (Phase 1) 1) From Edgard de Souza Dam to Coffer Dam (at the meeting point with Pinheiros River): 16.5km 2) Design safety degree against flood: 1/100 3) Design section base width: 60-100m (Design section type: Trapezoidal 1V: 2H)	=>Almost as planned 1) and 2) is as planned 3) Design section base width: 54-61m (In addition, one arch-style bridge for pedestrian passageway was constructed by local funds.)
	Hydraulic Improvement of the Cabuçu de Cima River 1) From the meeting point between Cabuçu de Cima River and Tietê River to Três Cruzes Bridge: 10.5km 2) Design safety degree against flood: 1/100 3) Design section base width: Design section type is trapezoidal (trapezoidal section 10-20m) and rectangular (rectangular section 15-30m)	=>Almost as planned 1) 10.3km 2) As planned 3) As planned（But the portion of the Trapezoidal section increased） （In addition, 7 bridges were reconstructed from local funds.）
	Upper Tietê Water Resource Development Construction of Dams (Paraitinga Dam and Biritiba Dam） and Interconnection water canals	=>（Dam） Partly modified =>（Interconnection water canals） As planned（But the construction was implemented by the State government funds.）
	Hydraulic Improvement of the Tietê River (Phase 2) 1) From the meeting point of Pinheiros River to Peña Dam: 24.5km 2) Design safety degree against flood: 1/100 3) Design section average width: 50m (Design section type: Trapezoidal)	=>1), 2) and 3) as planned
	Civil Works in the Lower Tietê River Basin 1) Heightening and improvement works of Porunduva Dike (Near the Pirapora reservoir) 2) Strengthening of Pirapora Dam 3) Improvement of connecting road (Romeiros Road): 2.9km	=>1) and 3) As planned =>2) Cancelled

	Consulting Service（Phase 1 and 2） 1)Phase 1 =>Total 118M/M 2)Phase 2 =>Total 128M/M	=>1）M/M increased（Total 206 M/M） =>2）Almost as planned（Total 122M/M）
(2) Project Period	Phase 1: July 1995 to May 2000 （4 years and 11 months）	Phase 1: July 1995 to June 2003 （8 years）
	Phase 2: June 2000 to February 2006 （5 years and 9 months）	Phase 2: June 2000 to February 2006（5 years and 9 months）
(3) Project Cost Foreign Currency Local Currency Total ODA Loan Portion Exchange Rate	39,149 million yen 43,230 million yen （325,038 thousand U.S. dollars） 82,379 million yen 49,427 million yen 1U.S. dollar =133 JPY (June 1995)	49,386 million yen 21,066 million yen （181,057 thousand U.S. dollars） 70,452 million yen 49,386 million yen 1 U.S. dollar=116.35JPY (average between January 1996 and December 2005)

Ex-Post Evaluation Report of Japanese ODA Loan Project
Colombia

Bogota Water Supply Improvement Project

External Evaluator: Kenichi Inazawa
(Office Mikage, LLC)
Field Survey: March and July 2009

1. Project Profile and Japanese ODA Loan

Map of the Project Area


San Rafael Reservoir and Pumping Station

1.1 Background

The capital of the Republic of Colombia, Bogota[1], is a political, economic, and cultural center of the country. By the commencement of this project in 1991, Bogota City had been developing water resources, constructing water transmission and purification facilities, and so on, with the goal of meeting the water demand until 2005; however, the supporting facilities for water-conducting facilities, such as reservoirs and water distribution facilities, had not been sufficiently developed. For this reason, the water supply facilities as a whole were not functioning well, and urgent measures were required to achieve a stable water supply.

Given this background, this project was implemented as a part of the Fourth Bogota Water Supply and Sewerage Project (1985−1993), which was under the initiative of the World Bank. Under the World Bank loan project, the project purpose was to develop a water distribution and sewage network in Bogota City, to implement a flood control survey, and to strengthen the organizational structures of the Executing Agency, Empresa de Acueducto y Alcantarillado de Bogotá (Bogota Aqueduct and Sewer Company; EAAB). Meanwhile, the Japanese ODA loan project was to construct the reservoirs and pumping station, to develop monitoring and control system (control center) for integrated management of the water distribution facilities, and to procure vehicles for operation and maintenance.

[1] Bogota is located in the center of Colombia at an altitude of approximately 2,600 meters above sea level. The area of Bogota City is 1,587km^2, approximately 2.6 times larger than the area of the 23 wards of Tokyo (622km^2). Its population is approximately 7 million people, approximately 2 million people fewer than the population of the 23 wards of Tokyo (8,770,000 people in April 2009).

1.2 Project Objective

The objective of this project is to expand the water supply capacity of the water treatment plant, to stabilize the water supply, and to increase the number of population served by constructing a reservoir and pumping station, installing a monitoring and controlling system, and procuring vehicles and heavy machines in Bogota City, where it is a political, economic, and cultural center of Colombia; thereby contributing to the improvement of the health of the residents and to the industrial development of the city.

1.3 Borrower / Executing Agency

Bogota Aqueduct and Sewer Company（Empresa de Acueducto y Alcantarillado de Bogotá: EAAB), guaranteed by the Government of the Republic of Colombia / Bogota Aqueduct and Sewer Company (EAAB)

1.4 Outline of Loan Agreement

Loan Amount / Loan Disbursed Amount	8,375 million yen / 6,374 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	December 1989/December 1991
Terms and Conditions	
Interest Rate	4.75%
Repayment Period (Grace Period)	25 years（7 years）
Procurement	Compound untied
Final Disbursement Date	December 2004
Main Contractors (Over 1 billion yen)	Electrohidraulica Ltda. (Colombia)・A.F.S.K. Industries Ltd. (Israel）（J/V）/Impregilo S.P.A.（Italy）/ Nepomuceno Y Cartagena G.E. Hijos (Colombia) / Mitsubishi Corporation (Japan)
Main Consultants (Over 100 million yen)	-
Feasibility Study (F/S)	F/S 1984 (Prepared by EAAB)
Related Projects	From 1985 to 1993: The Fourth Bogota Water Supply and Sewerage Project (financed by the World Bank)

2. Evaluation Result (Rating: A)

2.1 Relevance (rating: a)

2.1.1. Relevance at Time of Appraisal

In the economic development plan (1991−1994) established by the Gaviria administration in 1991, health and sanitation, water supply, education, roads, and railways were stated as the priority development sectors. Even before this administration, the Government of Colombia had been placing importance on social infrastructure development, which was seen in the fact that economic development to improve the nationals' standard of living was stipulated as a medium-term goal in the national development plan (1983−1986).

In Bogota City, the Fourth Bogota Water Supply and Sewerage Project was being implemented, and importance was placed on 1) development of a water distribution system to improve water shortages in the southwestern part of Bogota City (a low-income neighborhood), 2) improvement of the stability of the water supply system in Bogota City through the construction of reservoir, 3) improvement and function enhancement of operation and maintenance facilities, and 4) improvement of the productivity and operational and managerial efficiency of the Executing Agency through the technical assistance. Furthermore, the Chuza reservoir, located approximately 40km east of Bogota City, was the largest water resource in the Bogota Capital District at the time of the appraisal. It was assumed that if the existing aqueducts connecting from the Chuza reservoir to the Weisner water treatment plant[2] should be damaged or stop working due to accidents, it would be impossible to supply enough purified and treated water by relying on the capacity of other water treatment plants in Bogota City. Therefore, securing backup water resources and constructing supporting facilities to provide a stable water supply were regarded as necessary.

2.1.2. Relevance at Time of Evaluation

The water supply sector is stated as a major sector for stimulating sustainable development in the current national development plan (2006−2010) as well. The Government of Colombia places importance on the improvement of the water and sanitation services in this plan, with the aims of poverty reduction and employment creation. Meanwhile, in 2006, Bogota City established the Water Supply and Sewerage Master Plan, dealing with water supply and demand adjustment, securing water resources, and the improvement of the water supply and sewerage services, and so on.

Regarding the implementation of the Fourth Bogota Water Supply and Sewerage Project, expansion of the overall water supply facilities in Bogota City was achieved through expansion

[2] This is the water treatment plant with the largest water treatment capacity in Bogota City. (See Effectiveness on p. 11: "Water treatment capacity of the plants in Bogota City")

of the water distribution facilities, upgrading of the water distribution network, construction of reservoirs and pumping station. Through the implementation of this project, a water distribution network centered on low-income neighborhoods was developed, and 1.8 million people of Bogota City could newly receive water supply and sewerage services[3]. Meanwhile, it has been recognized that the San Rafael reservoir and pumping stations, which were constructed through the Japanese ODA loan project as backup water resources and supporting facilities, are important for maintaining the structures needed for a stable water supply to Bogota City. Furthermore, the importance of monitoring and control system, which has adopted the latest technologies, is high for the efficient operation of the water supply and water distribution systems, and the provision of services.

After the commencement of this project, the water demand fell[4] due to water-saving initiatives by the Bogota City Government, but it is expected that future population growth will lead to a rising trend in the demand for water supply. The Executing Agency predicts that in the future, the daily average amount of water supply to Bogota City will rise by approximately 25,900m^3/day (approximately 0.3m^3/second). Therefore, this project retains its high level of importance as a foundation to meet future increase in demand for water supply.

Regarding the above, this project has been highly relevant with Colombia's national policies and development needs at the times of both appraisal and ex-post evaluation.

2.2 Efficiency (Rating: b)

2.2.1. Outputs

This project constructed a reservoir[5] with a capacity of 75 million m^3 and a pumping station (San Rafael reservoir and pumping station), developed a monitoring and control system, and procured vehicles and heavy machines for operation and maintenance as almost planned in the appraisal. Table 1 shows a comparison of planned and actual major outputs.

[3] The source information is from the evaluation report "the Fourth Bogota Water Supply and Sewerage Project" on the web site of Independent Evaluation Group (IEG) of the World Bank.

[4] For the activities of saving water and controlling water demand, see "Amount of Water Supply" at Effectiveness (p. 12).

[5] However, the civil work for the reservoir dam was within the scope of the World Bank loan.

Table 1: Comparison of Planned and Actual Outputs

Outputs	Planned	Actual
1. Construction of San Rafael Reservoir and Pumping Station	• Capacity of reservoir: 75 million m^3 • Pumping station: the capacity of 12 m^3/sec.（4 m^3/sec.×3 units） • Copper pipe from the reservoir: connection to Wisner water treatment plant (2.5m radius, 740m length)	=>Almost as planned − the pumping capacity is 16 m^3/sec.（4 m^3/sec.×4 units）
2. Development of Monitoring and Control System (Control Center)	• Control center: 1 building • Equipment: PC, software, electric generator, etc. • Small wireless communications facilities to allow remote control: 54 sites[6]	=>Almost as planned Additional outputs: The number of the remote control sites increased by 53 sites, using funds of the Executing Agency. So there are now 107 sites.
3. Procurement of Vehicles and Heavy Machines (Vehicles for Water Supply and Sewage Maintenance, Transport Vehicles and Heavy Machines for Cleaning and Maintenance)	• New procurement: 332 units • Repair: 28 units (total: 360 units)	=>Almost as planned (the total number of the vehicles and heavy machines is 341 : 240 units of vehicles and 101 units of heavy machines. (* The new procurement only was carried out, as the vehicles and heavy machines that were to be repaired had already reached the end of their serviceable life.)
4. Consulting Service	• The planned M/M is unknown.	=>Implemented by using funds of the Executing Agency（Total: 66M/M）

Source: JICA documents, Project Completion Report (PCR) and Answers on questionnaires

The following explanation provides reasons for the differences between the planned and actual outputs shown in Table 1.

[6] By connecting the control center and the water treatment plant, pumping station, reservoirs, and distribution networks through a telecommunication network, information on water amount, water pressure, water level, and water quality can be collected efficiently.

Construction of San Rafael Reservoir and Pumping Station[7]

The reason for the additional pumping unit is that there will be an increased demand on the water supply in the future. Furthermore, there is space to put one more unit[8] in the pumping station.

Figure 1: Outside View of Pumping Station

Figure 2: Inside View of Pumping Station (pumping units are set at the bottom)

Development of Monitoring and Control System

The Executing Agency added more remote control sites (small wireless communications facilities) with its own funds because it judged that it was necessary to increase the communications facilities in the water distribution facilities of the city, for the purpose of efficiently operating the water distribution network from the control center. As a result of increasing the number of the remote control sites, the operational structures of the communications systems were strengthened.

Figure 3: Outside View of Control Center

Figure 4: Control Room for Water Supply and Distribution

Procurement of Vehicles and Heavy Machines

In the appraisal, both the procurement and repair of vehicles and heavy machines were planned. However, the vehicles and heavy machines slated for repair had already reached the end of their serviceable life, so repairs were not carried out. Only procurement of new vehicles was carried out.

[7] The pumping station has a ground floor and five basement floors. On the bottom-most basement floor (the fifth floor) four pumping units are being placed.

[8] If the water demand increases more in the future, one more pumping unit will be installed so that the total number of pumping units is five.

Figure 5: Vehicles

Figure 6: Heavy Machines

Consulting Service

Although the cost of the consulting service was planned to be covered by the Japanese ODA loan, project cost allocation was revised during the project implementation with JICA's concurrence. As a result, the original budget for the consulting service was used for the development of the monitoring and control system (control center), and the consulting service itself was implemented by using funds of the Executing Agency (66 M/M in total).

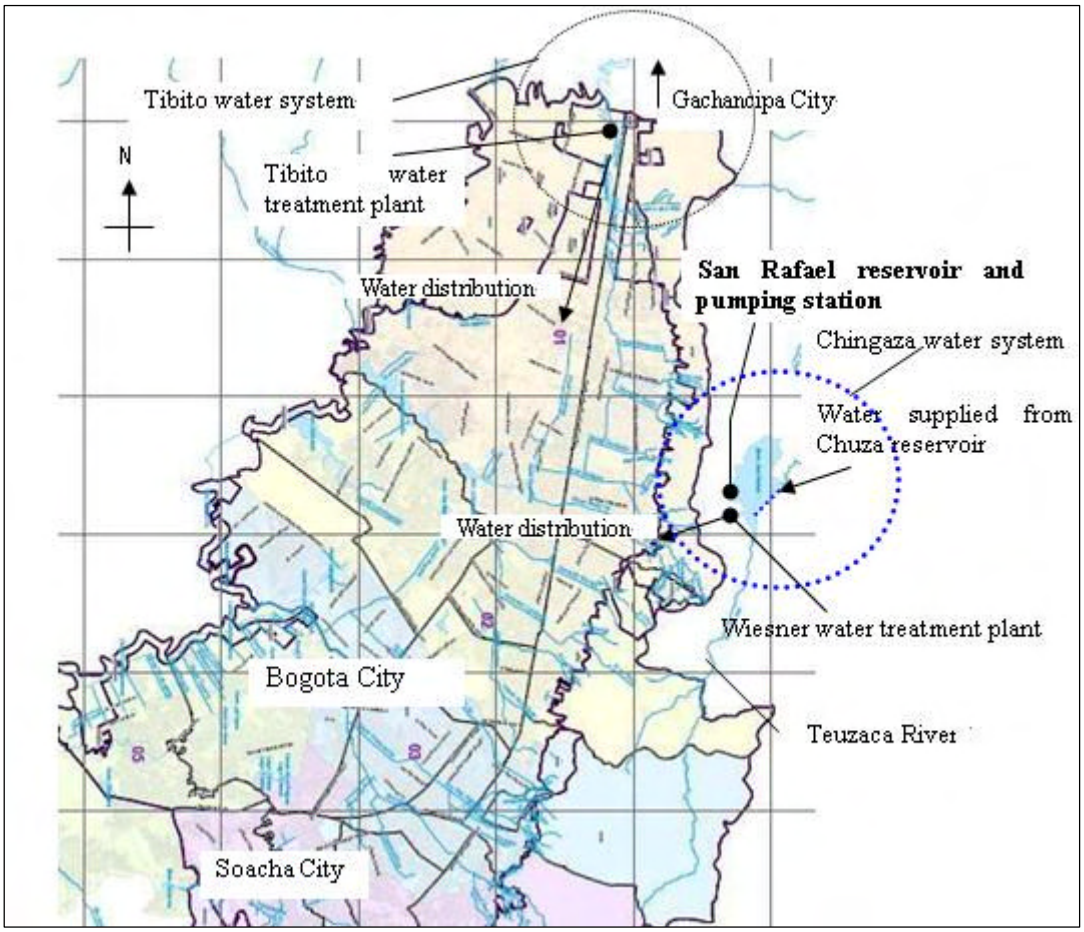


Figure 7: Project Site[9]

[9] The Chingaza water system shown in Figure 7 is the water resource system that brings raw water from the Chuza reservoir (located approximately 40km east of Bogota City) to the Wiesner water treatment plant and raw water

Reference: Outputs of "The Fourth Bogota Water Supply and Sewerage Project"

The following table shows the outputs and the implementation status of the Fourth Bogota Water Supply and Sewerage Project, which is covered by the Japanese ODA loan and World Bank loan. The World Bank portion in The Fourth Bogota Water Supply and Sewerage Project was implemented from April 1985 to June 1993, lasting approximately 8 years.（The total project cost is around 330 million U.S. dollars）

Table 2: Outputs of "The Fourth Bogota Water Supply and Sewerage Project"

Outputs	Aid Agencies	Inplementation Status
1) Construction of Water Transmission and Distribution Facilities（construction of approx. 43km of transmission and primary water distribution mains; construction of 6 booster pumping stations, etc.）	World Bank	Completed in 1993
2) Rehabilitation of Water Transmission and Distribution Pipelines (replacement and rehabilitation of water distribution mains: approx. 280km in total, etc.）	World Bank	Completed in 1993
3) Construction of Secondary Water Networks and Service Connections (water mains: approx. 140km; sewage collection: about 280km; water and sewage connections with water meter: 100,000 units; replacement of the water meters: approx. 260,000 units）	World Bank	Completed in 1993
4) Construction of San Rafael Reservoir and Pumping Station（civil works for the reservoir dam was implemented with the World Bank loan）	JICA/ World Bank	Completed in 1996
5) Development of Monitoring and Control System (control center)	JICA	Completed in 2007
6) Procurement of Vehicles and Heavy Machines (vehicles for water supply and sewage maintenance, transport vehicles and heavy machines for cleaning and maintenance, etc.）	JICA	Completed in 1997
7) Study for Mitigation of Pollution of the Bogota River and Flood Control	World Bank	Completed（Completion date is unknown）
8) Strengthening of the Organizational Structure of the Executing Agency	World Bank	Completed（Completion

from the San Rafael reservoir that comes from the Teusaca River, flowing south-to-north in the suburb of Bogota City. The Tibito water system is the water resource system that mainly brings raw water from the Bogota River, flowing approximately 35km north of Bogota City.

(technical assistance for strengthening the management system and drafting a financial plan, and so on.)		date is unknown)

Source: JICA documents and Executing Agency documents

2.2.2 Project Period

This project was planned to be completed in 4 years and 4 months, from December 1991 to March 1996. However, as shown in Table 3, it took 15 years and 5 months, lasting from December 1991 to April 2007, an overrun of 11 years and 1 month (356% of the plan). The main reason for the delay was that the procurement of the monitoring and control system was delayed. For the development of the monitoring and control system, a turnkey[10] contract was introduced under which a detailed design was implemented by a contractor; however, the Executing Agency was unfamiliar with the procurement procedures, so preparation of the bidding documents was delayed and the procurement procedures required a long time.[11] Subsequently, the JICA project supervision study mission[12] was dispatched to provide procurement support. Compared to the planned period, as a result, there was a long delay.

Table 3: Comparison of Planned and Actual Period

Outputs	Planned	Actual
The Whole Project	December 1991 to March 1996 (4 years and 4 months)	December 1991 to April 2007 (15 years and 5 months)
1) Construction of San Rafael Reservoir and Pumping Station	December 1991 to March 1996	December 1991 to May 1996
2) Development of Monitoring and Control System	January 1993 to March 1996	October 1996 to April 2007
3) Procurement of Vehicles and Heavy Machines	April 1992 to June 1993 April 1994 to June 1995	February 1996 to September 1997[13]

Source: JICA documents, Project Completion Report (PCR) and Answers on questionnaires

[10] Turnkey is a type of contract in which the equipment and facilities can be used immediately after delivery. This type of contract is mainly used for plant construction. The name comes from the idea that as soon as the beneficiary "turns the key," the equipment or facilities can be operated (used as soon as delivery has been completed).

[11] In 2000, the start of the bidding delayed due to a delay in the approval process of domestic public investment budgets in Colombia.

[12] The mission conducted a survey on the problem areas of the bidding and supported drafting bidding documents for rebidding. It also provided bidding evaluation support and transferred procurement management knowhow (2002−2003).

[13] The reason for the delay in the procurement of vehicles and heavy machines is that the ordering, manufacturing and transporting of the vehicles and heavy machines required longer time than estimated because they were imported from overseas.

2.2.3 Project Cost

The total planned project cost was 11,090 million yen (the Japanese ODA loan amount was 8,375 million yen), and the actual total project cost was 10,216 million yen (the Japanese ODA loan amount was 6,374 million yen), which was below the planned cost (92% of the planned). The main reason for cost reduction is the cost savings as a result of competitive bidding.

As above, the project cost was lower than planned, but the project period was much longer than planned; therefore the evaluation for efficiency is moderate.

2.3 Effectiveness (rating: a)

2.3.1 Effectiveness Evaluation by Operation and Effect Indicators

2.3.1.1 Population Served, Percentage of Population Served, and the Number of Families Served

Table 4 below shows the change over time in the number of people supplied with water (population served). Due to limitations in the data, the estimated figures for the time of the appraisal (1991) show the total[14] for Bogota City and the adjacent, Soacha City. Meanwhile, the actual figures for the population served and the total population cover only Bogota City[15], the city targeted by this project.

Although the estimated value of population served and the actual population are not exactly comparative, the actual value has gradually increased. Therefore, it can be judged that the water supply is stable.

[14] The Executing Agency did not have the population served and total population data for only Bogota City (estimated value at time of the appraisal), and it was not possible to obtain that data for use in this ex-post evaluation activity.

[15] The Executing Agency calculates the actual number of population served by "multiplying the actual number of households receiving the water supply (number of contracts) by the average number of people per household." The "average number of people per household" is determined by using reference to data such as the national census, which is implemented once every five years (example, 4.8 people per household). As a result of this, a phenomenon occurs in which the number of population served is greater than the total population. (This occurs in 2003, 2005, 2006, and 2008. The national census is not implemented every year, so when the number of population served is calculated by multiplying by "the average number of people per household last year or earlier," the total exceeds the total population as a mathematical phenomenon.)

Table 4: Transition of Population Served in Bogota City（Unit: thousand people）

Estimated Value at the Appraisal[a]			Actual Value[b]		
Year	Population Served	Total Population	Year	Population Served	Total Population
1995	6,086	6,211	1995	4,927	5,678
1996	6,248	6,375	1996	5,352	5,815
1997	6,407	6,538	1997	5,523	5,956
1998	6,564	6,698	1998	5,753	6,112
1999	6,720	6,857	1999	6,015	6,276
2000	6,876	7,016	2000	6,166	6,437
2001	7,031	7,174	2001	6,318	6,573
2002	7,182	7,328	2002	6,657	6,712
2003	7,330	7,479	2003	6,953	6,865
2004	7,477	7,629	2004	6,913	7,029
2005	7,624	7,779	2005	6,974	6,840
N/A			2006	7,196	6,945
			2007	6,952	7,050
			2008	7,266	7,155

Source: JICA documents（at the appraisal）, Executing Agency documents and data from Statistics Bureau of Colombia (Actual value)

[a] The population served and the total population include both Bogota City and Soacha City.

[b] The population served and the total population include only Bogota City.

Furthermore, the percentage of population served as of project completion was estimated at around 98% at the appraisal. In recent years, the percentage has grown to nearly 100%, which is sustained at a high level.

In addition, the number of families served in Bogota City tends to be growing. There were 1,617,793 families in 2006, 1,669,912 families in 2007, and 1,732,830 families in 2008; the number of families that subscribe water supply services of the Executing Agency has been increasing year by year.

Water Treatment Capacity of the Plants in Bogota City

The San Rafael reservoir and pumping station are adjacent to the Wiesner water treatment plant. Water is supplied to the plant from the Chuza reservoir, from San Rafael reservoir, and from the pumping station, and it is purified and treated at the Wiesner plant. Then, the purified and treated water is supplied to Bogota City. As of 2009, the Executing Agency has six water treatment plants in Bogota City. The following table shows the treatment capacity of each treatment plant.

Figure 8: Wiesner Water Treatment Plant

Table 5: Water Treatment Capacity at the Appraisal and the Ex-Post Evaluation

At the Appraisal (Actual)			At the Ex-Post Evaluation		
Water Treatment Plant	m^3/sec.	(Thousand m^3 /Day)	Water Treatment Plant	m^3/sec.	(Thousand m^3/Day)
Wiesner	14.0	1,210	Wiesner	18.0[a]	1,555
Tibito	12.0	1,037	Tibito	12.0	1,037
Others	1.9	164	Dorado	1.6	138
—			Vitelma	1.1	95
			Laguna	0.45	39
			Yomasa	0.025	2
Total	27.9	2,411	Total	33.175	2,866

Source: JICA documents (at the appraisal), Executing Agency documents and Answers on questionnaires (at the ex-post evaluation)

[a] The Executing Agency expanded its water treatment filter capacity in 2006 and 2007 and secured 18 m^3/sec. as the treatment capacity (+4 m^3/sec. increased). According to the Executing Agency, a maximum 19 m^3/sec. as the boosting capacity is also possible.

2.3.1.2 Amount of Water Supply

The following table shows the estimated amount of the average daily water supply (at the appraisal) and the actual amount of the average daily water supply. The amount of the average daily water supply for all of Bogota City and only the Wiener water treatment plant is shown in the table.

Table 6: Amount of the Average Daily Water Supply of both the Entire Bogota City and Only the Wiener Water Treatment Plant (Unit: thousand m^3/day)

Estimated Value at the Appraisal			Actual Value		
Year	Amount of the Average Daily Water Supply of the Entire Bogota City	Amount of the Average Daily Water Supply of Wiener Water Treatment Plant	Year	Amount of the Average Daily Water Supply of the Entire Bogota City	Amount of the Average Daily Water Supply of Wiener Water Treatment Plant
1991	1,307	852	1991	N/A	N/A
1995	1,521	1,066	1995	1,554	1,020
1996	1,580	1,125	1996	1,519	953
1997	1,640	1,096	1997	1,337	448
1998	1,740	1,096	1998	1,356	804
1999	1,767	1,096	1999	1,279	734
2000	1,859	1,096	2000	1,276	812
2001	1,893	1,096	2001	1,271	729
2002	1,964	1,096	2002	1,272	752
2003	2,006	1,096	2003	1,250	758
2004	2,058	1,096	2004	1,235	809
2005	2,113	1,096	2005	1,227	890
N/A			2006	1,246	925
			2007	1,273	895

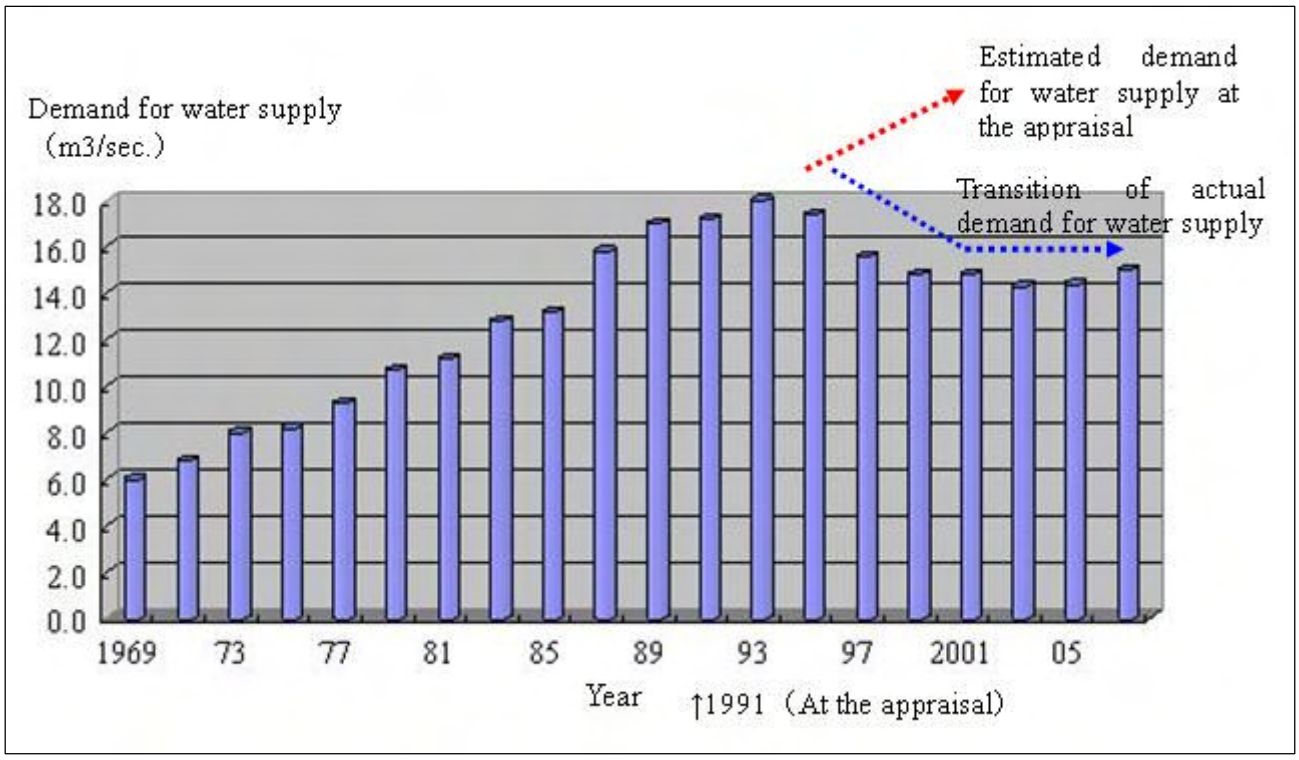
	2008	1,299	802

Source: JICA documents（at the appraisal), Project Completion report (PCR) and Executing Agency documents (actual value)

At the time of the appraisal (1991), it was believed that population growth would lead to a rapid increase in the demand for water supply in Bogota City. However, as shown in Figure 9, the demand for water supply began to fall in the mid-1990s, and currently approximately 14-15m^3/second of water is being supplied. The followings are the major reasons for this reduction in demand: (1) since the mid-1990s, the amount of water consumed in Bogota City has been reduced due to initiatives of the Executing Agency to improve the water tariff structure (raising water rates); (2) water supply meters have been installed in many households, and, as a result, the Executing Agency has been able to measure and control the amount of water supply more appropriately; and (3) the amount of water consumed by citizens has been reduced through the Bogota City government's water saving campaigns (publicity and educational campaigns). However, the population of Bogota City is increasing,[16] albeit only moderately, so it is considered that in the future, the demand for water supply will rise along with population growth.

Furthermore, the reduction in the actual amount of water supplied by the Weisner water treatment plant in 1997 (to 448,000 m^3/day), shown in Table 6, occurred because in that year, the existing aqueducts between the Chuza reservoir and the Weisner Water Treatment Plant were damaged and unable to conduct water for approximately nine months. While the work to restore these aqueducts was underway, the San Rafael reservoir and pumping station played an important role as backup water resource and supporting facilities. In other words, it is another reminder of the value of implementing this project.

[16] According to data from the Statistics Bureau of Colombia, the annual population growth rate from 2010 to 2015 is expected at 1.35%.



Source: Executing Agency documents

Figure 9: Transition of Demand for Water Supply in Bogota City

2.3.1.3 Unaccounted-for Water Rate

Table 7 shows the transition of the unaccounted-for water rate in Bogota City. In recent years, the rate has remained largely the same. According to the Executing Agency, the unaccounted-for water derives from leaked and stolen water from distribution facilities. The unaccounted-for water rate in other Latin American and Caribbean countries is shown in Table 8. Although the unaccounted-for water rate in Bogota City is lower than in other Latin American countries, there has been no great improvement in recent years.

Table 7: Transition of the Unaccounted-For Water Rate in Bogota City

2003	2004	2005	2006	2007	2008
37.95%	37.87%	35.95%	36.76%	35.00%	36.40%

Source: Executing Agency documents

Table 8: Unaccounted-For Water Rate in Other Latin American and Caribbean Countries

Iquitos City, Peru (2003)	Rural Areas in Costa Rica (Unknown)	Panama Metropolitan Area (2002)	Nationwide Average in Mexico (2000)
63%	More than 50%	48%	40%

Source: JICA document "The Role of Private Sector Participation (PSP) for Sustainable Water Supply and Sanitation Sectors (2004)"

Reference: Water Quality of the Water Treatment Plants in Bogota City

Table 9 below shows the water quality level of both the Wiesner water treatment plant, which is adjacent to the San Rafael reservoir and pumping station, and other plants in Bogota City. The water quality level of the Wiesner plant meets the national water quality standard. In addition, there are chlorine and medicine injection facilities inside the plant that disinfect and sterilize the water. The quality of the purified and treated water in the plant is monitored regularly at a laboratory. The water quality data from every water treatment plant in Bogota City is reported regularly to the Water Supply Division of the Executing Agency.

Table 9: Water Quality of Water Treatment Plants in Bogota City

At Time of Appraisal					At Time of Ex-Post Evaluation				
Water Treatment Plant	Impurity (NTU)	Chromaticity (UC)	pH	Residual Chlorine (mg/L)	Water Treatment Plant	Impurity (NTU)	Chromaticity (UC)	pH	Residual Chlorine (mg/L)
Wiesner	1.10	10.00	6.80	1.16	Wiesner	0.93	5.00	6.69	1.47
(The following data is for reference: Water quality level of the other water treatment plants.)									
Tibito	2.80	10.00	6.40	1.36	Tibito	0.19	5.00	6.66	1.57
Vitelma	1.50	9.00	7.00	0.60	Vitelma	N/A	N/A	N/A	N/A
Dorado	N/A	N/A	N/A	N/A	Dorado	0.34	1.78	6.81	1.54
Laguna	6.70	17.00	6.50	0.78	Laguna	N/A	N/A	N/A	N/A
San Diego[a]	2.80	10.00	6.60	0.43	Yomasa	0.75	4.21	6.96	0.97
—					Water Quality Standard in Colombia	Less than 2.00	Less than 15.00	6.50−9.00	0.30−2.00
					(Reference) Water Quality Standard of Tap Water in Japan (Water Supply Law by the Ordinance of Ministry of Health, Labor and Welfare)	Less than 2.00	Less than 5.00	5.80−8.60	Less than 1.00

Source: JICA documents (at the appraisal), Answers on questionnaires (at the ex-post evaluation), and Information on the web site of the Bureau of Waterworks of Tokyo Metropolitan Government.

[a] The San Diego water treatment plant stopped operation in March 2003. Instead, a new plant like the one in Yomasa has been working.

2.3.2 Recalculation of Financial Internal Rate of Return (FIRR)

The financial internal rate of return (FIRR) was recalculated based on a project life of 30 years, with revenue from water charge set as benefit, and initial investment and operation and maintenance cost set as costs. The result was calculated at 12.6%, which is close to the 13.3% calculated at the appraisal.

2.3.3 Recalculation of Economic Internal Rate of Return (EIRR)

The recalculation was not carried out because the economic internal rate of return (EIRR) was not calculated at the appraisal and because it was also difficult to collect the benefit data of "Willingness to Pay (WTP)" for water quality improvement, etc.

2.3.4 Qualitative Effect

2.3.4.1 Implementation of Beneficiary Survey

This ex-post evaluation survey conducted a beneficiary survey in Bogota City and Soacha City where the Executing Agency provides the water service. The sample size was 200, of which 141 people are from the residential area and 59 people are from the commercial area. The following graphs show the results of each of the beneficiary surveys. Overall, it seems the water quality and pressure are generally good, and the water service provided by the Executing Agency has credibility from beneficiaries.

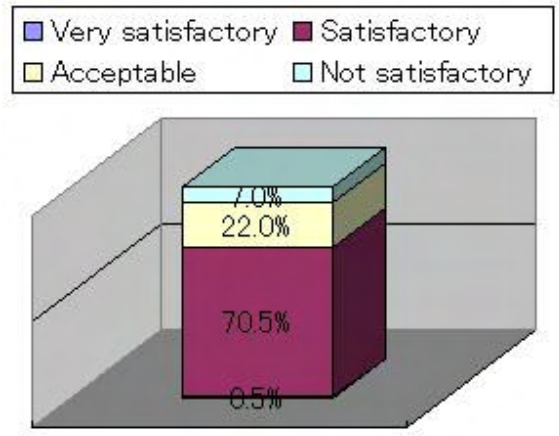


Figure 10: Water Pressure

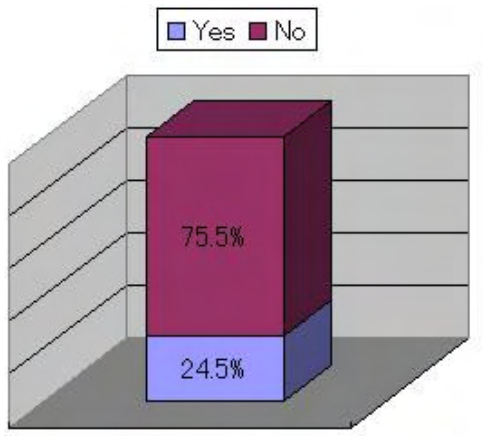


Figure 11: Presence of Water Impurity

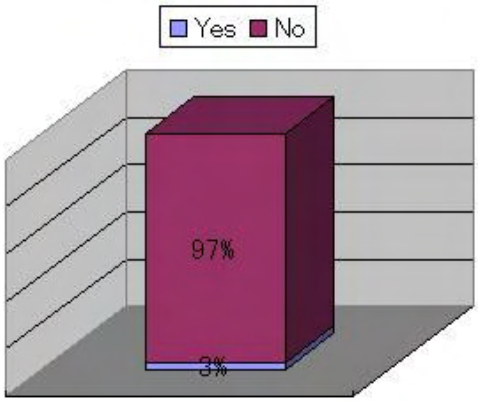


Figure 12: Presence of Water Stench

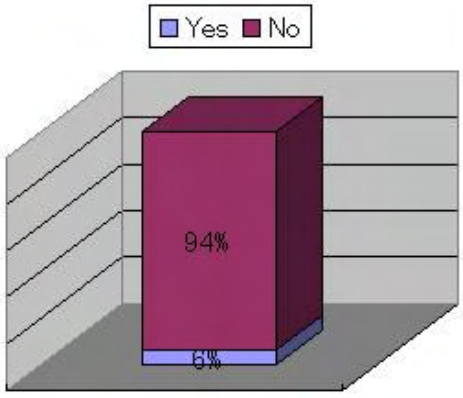


Figure 13: Presence of Diarrhea-Related Disease in the Last 15 Days

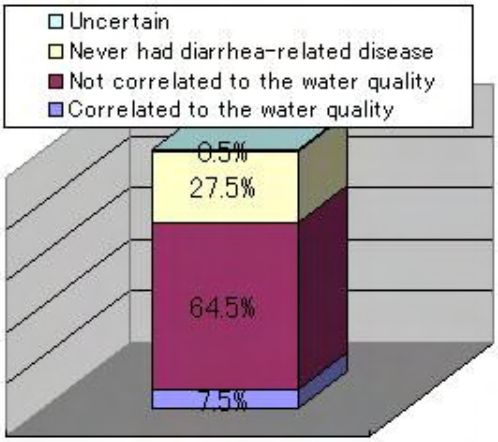


Figure 14: Correlation Between Diarrhea-Related Disease and Water Quality

Figure 15: Service of the Executing Agency

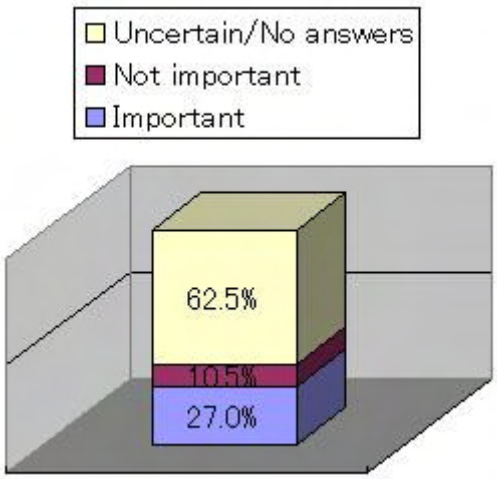


Figure 16: Importance of San Rafael Reservoir[17]

[17] The reason that the proportion of the answer "Uncertain / No answers" is high seems to be as much time has passed since the completion of the San Rafael reservoir and pumping station (1996).

Reference: Effect of "The Fourth Bogota Water Supply and Sewerage Project" (the World Bank portion)

As stated above, the water distribution facilities and sewerage facilities in Bogota City were developed with the World Bank loan, and, as a result, the 1.8 million people of Bogota City could newly receive water and sewerage services. The results of the beneficiaries survey stated in the previous paragraph are considered to reflect the effectiveness not only of the Japanese ODA loan project but also the project financed by the World Bank; therefore, as a whole, it can be said that implementation of the Fourth Bogota Water Supply and Sewerage Project provided a foundation for the strengthening of the water supply structure of Bogota City.

As a summary of Effectiveness, although the amount of water supply is lower than the demand for water supply estimated at the time of the appraisal − the result of water saving programs by the Executing Agency − the actual value of the population served fulfills more than 80% of the estimated value. In addition, the beneficiary survey results are good enough. Therefore, this project has largely achieved its objectives, and its effectiveness is high.

2.4 Impact

2.4.1 Improvement of the Health and Sanitary Aspect of the Residents in Bogota City

Figure 17 below shows the transition of the mortality rate of infants under five years old due to diarrhea related disease in Bogota City. As diarrhea related disease seems to be correlated to various elements other than water, it is difficult to verify the direct contribution of this project to the improvement of the mortality rate. However, the mortality rate by the diarrhea related disease has consistently been decreasing since the project initiation. Therefore, it can be assumed that the achievement of the safe and clean water supply has contributed to the improvement of the health and sanitary aspect to a certain extent.

.

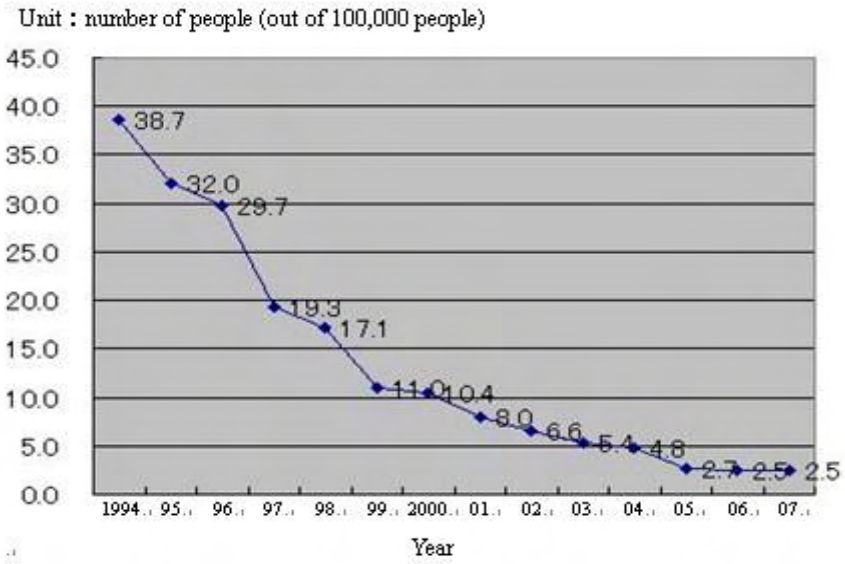


Figure 17: Transition of the Mortality Rate of Infants
Under Five Years Old due to Diarrhea Related Disease in Bogota City

Source: Executing Agency documents

An interview that was part of the beneficiary survey included questions about changes in beneficiaries' daily life, and there were positive comments such as "Housework can now be done without any worries. There is no fear about the sanitary aspect of washing and bathing" and "My work [business] is stable because of the 24-hour water supply service [Especially from shopkeepers]"

2.4.2 Impact on Industrial Development (Regional Economic Development)

As shown in Table 10, the Gross Regional Domestic Product in Bogota City has been increasing, overall. It cannot be stated with certainty that implementation of this project has had a direct impact on the economic and industrial development of Bogota City, but it can be inferred that achieving a stable water supply has had a positive impact on the economic and social activities of the citizens and companies of Bogota City. Therefore, it can be said about this project that "the stable water supply is supporting the economic and industrial activities of Bogota City." (The assumed number of beneficiaries of this project is the population of the Bogota Capital District, which is approximately 7 million people.)

Table 10: Gross Regional Domestic Product（Unit: million pesos）

Year	GRDP	Year	GRDP
1992	60,757,528	1999	72,250,601
1993	64,226,882	2000	74,363,831
1994	67,532,862	2001	75,458,108
1995	71,046,217	2002	76,917,222
1996	72,506,824	2003	79,884,490
1997	74,994,021	2004	83,772,433
1998	75,421,325	2005	87,727,925

Source: Statistical data from Central Bank of Colombia

2.4.3 Impact on Natural Environment, Resettlement of Residents and Land Acquisition

There was no negative impact on the environment due to the construction of the San Rafael reservoir, pumping station, and the monitoring and control system (control center). In addition, no noise or vibrations are occurring in the area near the pumping station.[18]

Furthermore, resettlement of residents and land acquisition did not occur in this project.

2.5 Sustainability (rating: a)

2.5.1 Executing Agency

2.5.1.1 Institutional Structure for Operation and Maintenance

The Executing Agency (EAAB) is the largest organization in Colombia that provides public services. Its total number of employees was 1,971 in April 2009. Although the total number of employees was 3,150 in 1990, which was before the project implementation, restructuring of the employees was conducted after the project initiation by introducing an early retirement program, for the purpose of establishing a more efficient organizational structure.

The Executing Agency is managed by the board of directors headed by the mayor of Bogota City. The general manager, appointed by the president (the mayor), is actually in a position to control the organization as a whole. At present, there are eight departments under the general manager: Department of Master System, Department of Planning and Control, Department of Law, Department of Finance, Department of Human Resources and Administration, Department of Client Services, Department of Technology, and Department of Environment.

The following is a description of the operation and maintenance system of the San Rafael reservoir and pumping station, monitoring and control system (control center), and vehicles and heavy machines.

[18] The pumping station facilities consist of one ground floor and five basement floors in a dome-type structure. This prevents the surrounding areas from being affected by noise or vibration problems. Furthermore, the reservoir is located in a valley that has no buildings to be affected by noise.

1） O&M System of San Rafael Reservoir and Pumping Station

The Water Supply Division, which is a subordinate section of the Department of Planning and Control, and the maintenance team at the Wiesner water treatment plant are in charge of its O&M. The number of employees is 12. The maintenance of the pumping station is outsourced, only in the case when a high degree of technical expertise and/or special maintenance is necessary.

2） O&M System of the Monitoring and Control System (control center)

The Electrical Services Division,[19] which is under the Department of Technology, is in charge of the O&M. The number of employees is 17. The work for the O&M is being conducted by means of a rotation system three times a day (24-hour operation).

3） O&M System of Vehicles and Heavy Machines

The Electrical Services Division is also in charge of the O&M of the heavy machines, and the Administration Division (under the Department of Planning and Control) is in charge of the O&M of the vehicles. There are three employees each from both the Electrical Services Division and Administration Division in charge of these operations. O&M of heavy machines is carried out by the Executing Agency itself and by means of outsourcing. Normal maintenance and repair is carried out at the repair workshop located at the head office of the Executing Agency, and O&M is outsourced to private companies only when major maintenance or repair are deemed to be necessary.

As stated above, the O&M system of this project has no problems, as it cannot be discerned particular problems regarding the number of the employees and the maintenance system.

Figure 18: Pumping Station Facilities (the bottom floor)

Figure 19: Repair Workshop at the Head Office of the Executing Agency

2.5.1.2 Technical Capacity for Operation and Maintenance

There are various training programs related to the business operation in the Executing Agency. A total of 105 training courses were held in 2008, and 4,487 regular employees and 758

[19] The division is in charge of the maintenance of electric machines and equipment.

engineer employees[20] participated. Furthermore, operation manuals have been prepared for employees in each division. Therefore, there is no problem with the technical level of the O&M of the organization.

2.5.1.3 Financial Status for Operation and Maintenance

The Executing Agency changed the water tariff and restructured the organization in the 1990s. As a result, the financial status of the organization has been well. There is no financial support or subsidies from the central government, and the Executing Agency sustains an independent, profitable system. In addition, the Executing Agency has obtained a high rating （AA+ in 2008, AAA in 2009) in the assessment of its financial condition by a domestic rating organization (private entity), based on the fact that the Executing Agency has increased profits through providing a water supply service for the adjacent municipality governments.

The following table is the Statement of Income of the Executing Agency. In recent years, both sales and profits have been increasing.

Table 11: Statement of Income of the Executing Agency（Unit: million pesos）

	2004	2005	2006	2007
Operating Revenue	892,892	969,885	987,447	1,103,731
Operating Cost	385,972	414,648	448,479	498,807
Operating Profits	506,920	555,237	538,968	604,924
Profit Before Tax	135,800	191,925	190,171	269,886
Current net profit	120,440	154,566	184,587	155,069

Source: Executing Agency documents

Tables 12, 13, and 14 below show the maintenance costs of each output (San Rafael reservoir and pumping station, monitoring and control system, and vehicles and heavy machines). Through interviews with the Executing Agency managers and looking at actual maintenance work, it was confirmed that the maintenance costs of these outputs are sufficient at present.

The maintenance costs have been increasing year by year because the domestic consumption price index has been rising, and many equipment and machineries are in the state of requiring replacement. Further, according to the Executing Agency, the maintenance costs of the monitoring and control system increases by 5% in 2009 over the previous year.

[20] The number of the employees is the total for each.

Table 12: Maintenance Costs of San Rafael Reservoir and Pumping Station (Unit: thousand pesos)

Year	Maintenance Costs
2003	8,662,882
2004	9,433,425
2005	10,552,233
2006	10,449,680
2007	10,119,896
2008	12,132,649

Source: Executing Agency documents

Table 13: Maintenance Costs of Monitoring and Control System in 2008[21] (Unit: thousand pesos)

Items	Maintenance Costs
Insurance Cost	220,000
Operating Cost	420,000
Labor Cost for Monitoring and Control	72,000
Maintenance Cost of Electronics	880,000
Maintenance Cost of Civil Works	60,000
Utility Cost	84,000
Radio Frequency Cost	600,000
Administration Cost	584,000
Total	2,920,000

Source: Project Completion Report (PCR)

Table 14: Maintenance Costs of Vehicles and Heavy Machines (Unit: thousand pesos)

Year	Maintenance Costs
2003	2,100,549
2004	2,216,079
2005	2,323,559
2006	2,435,089
2007	2,573,646

Source: Executing Agency documents

Reference: Water Tariff

As shown in Table 15, water tariff rates are set in six brackets (Estrato), according to the level of the household income of the residents. (Estrato 1 is the lowest bracket.) The water tariff is determined by a combination of a fixed rate and metered rates based on the amount of use.

[21] As the monitoring and control system started operation in 2007, data exists for only one-year (2008) .

Table 15: Monthly Water Tariff (end of 2008)（Unit: pesos）

Users	Fixed Rate[a]	Metered Rate	
		Tariff Under the Use of 20 m^{3b}	Tariff Over the Use of 20 m^{3c}
Bracket 1	1,895	644	2,145
Bracket 2	3,790	1,287	2,145
Bracket 3	5,558	1,888	2,145
Bracket 4	6,316	2,145	2,145
Bracket 5	14,148	3,218	3,218
Bracket 6	17,306	3,433	3,433
Governmental Agencies	6,316	2,145	
Industries	8,211	2,961	
Commerce	9,474	3,218	

Source: Executing Agency documents

[a] Monthly fixed tariff of the contractors

[b] The tariff until the use equals an amount of 20 m^3 （the tariff in the table is per 1 m^3）

[c] The tariff when the use is over 20 m^3 （the tariff in the table is per 1 m^3）

2.5.2 Conditions of Operation and Maintenance

The following descriptions are about the conditions of operation and maintenance of each output of this project. Overall, these outputs are in a good condition.

1）Conditions of O&M of San Rafael Reservoir and Pumping Station

There is no problem with the O&M conditions of this output. Maintenance manuals are prepared, and the necessary spare parts are secured and managed well. Reports on the O&M activities are submitted to the Water Supply Division, and the O&M performance is monitored.

2）Conditions of O&M of the Monitoring and Control System (control center)

Necessary spare parts are secured and managed thoroughly, and the maintenance manuals are prepared. The control center has been commended by the central government for its good management practices.[22] During 2009, renewal of equipment (the modern equipment and technology introduced) in the monitoring and control system will be implemented.

3）Conditions of O&M of Vehicles and Heavy Machines

There is no particular problem with the conditions related to the O&M. Necessary spare parts are secured and managed, and the maintenance of the vehicles etc is conducted properly. Although more than ten years have passed since the vehicles were procured by this project, most vehicles are still being used. However, 60% of the vehicles face

[22] ISO9001 has also been obtained.

lifetime end, and the Executing Agency is planning renewals for some.

Judging above, no major problem has been observed in the capacity of the Executing Agency neither its operation nor its maintenance system; therefore, sustainability of this project is high.

Figure 20: Computing system in the Control Center

Figure 21: Children in Bogota

3 Conclusion, Lessons Learned, and Recommendations

3.1 Conclusion

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

3.2 Lessons Learned

As in the procurement of the monitoring and control system, a turnkey contract method was introduced under which the detailed design was implemented by a contractor, the type of contract was changed. However, the Executing Agency was unfamiliar with the procurement procedures, so there were delays in drafting the bidding documents, and the procurement procedures required a long time. The JICA project supervision study mission was dispatched and provided support for the procurement; nonetheless, it is assumed that at the stage in which the type of contract was changed, the procurement capacity of the Executing Agency could have been forecasted to some extent. Furthermore, as the World Bank was responsible for strengthening the capacities of the Executing Agency, it was necessary to have more efficient coordination among the aid organizations from the commencement of the project especially in the case of co-financing in addition to coordinating with the Executing Agency. The aid organizations should also verify the procurement implementation system and capacity of the Executing Agency at as early stage as possible and then take the appropriate actions.

3.3 Recommendations

N.A.

Comparison of Original and Actual Scope

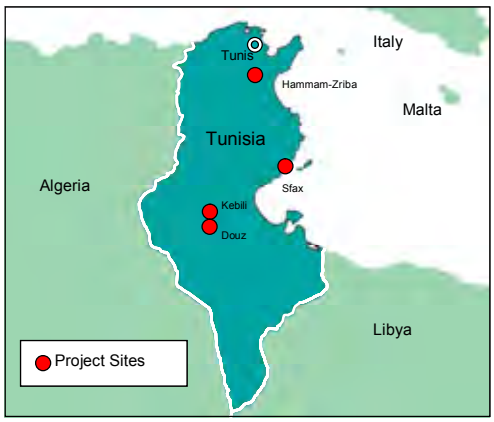
Items	Planned	Actual
(1)Outputs	1. Construction of San Rafael Reservoir and Pumping Station 1) Capacity of reservoir: 75 million m^3 2) Pumping station: the capacity of 12 m^3/sec.（4 m^3/sec.×3 units） 3) Copper pipe from the reservoir: Connection to Wisner water treatment plant（2.5m radius, 740m length） 2. Development of Monitoring and Control System (control center) 1) Control center: One building 2) Equipment: PC, software, electric generator, etc. 3) Small wireless communications facilities to allow remote control: 54 sites 3. Procurement of Vehicles and Heavy Machines (vehicles for water supply and sewage maintenance, transport vehicles and heavy machines for cleaning and maintenance, etc） 1) New procurement: 332units 2) Repair: 28 units (total: 360 units) 4. Consulting Service The planned M/M is not clear.	=> Almost as planned 1) Pumping capacity is 16 m^3/sec.（4 m^3/sec.×4 units） => Almost as planned 1） Additional outputs: The number of the remote control sites increased with 53 sites, which became 107 sites in total, by its own funds of the Executing Agency. => Almost as planned 1) The total number of the vehicles and heavy machines is 341 units: 240 units of vehicles and 101 units of heavy machines. => Implemented by its own funds of the Executing Agency（Total: 66M/M）
(2) Project Period	December 1991 to March 1996 （4 years and 4 months）	December 1991 to April 2007 （15 years and 5 months）
(3) Project Cost Foreign Currency Local Currency Total ODA Loan Portion Exchange Rate	 5,863 million yen 5,227 million yen （2,068 million pesos） 11,090 million yen 8,375 million yen 1 Col. peso＝0.3956 JPY （Feburary 1991）	 4,553 million yen 5,663 million yen （393 million pesos） 10,216 million yen 6,374 million yen 1 Col. peso＝0.0694 JPY （average during the project implementation period）

Tunisia

Sewage System Development Project in 4 Cities

External evaluator: Hajime Onishi
(Mitsubishi UFJ Research and Consulting Co., Ltd.)
Field Survey[1]: April 2009 and July 2009

1. Project Profile and Japanese ODA Loan



Map of Project Area

(Clockwise from upper left) Zriba Sewage Treatment Plant, Sfax North Sewage Treatment Plant, Kebili Sewage Treatment Plant, Douz residential area

1.1. Background

In the latter 1980s, Tunisia experienced an economic crisis triggered by a decline in the price of crude oil, a major export, and a precipitous drop in tourism income, but subsequent economic deregulation proved successful, leading to a recovery of growth in the 1990s. On the other hand, against the backdrop of a high population growth rate not only in the urban area but also in the rural area and the associated environmental problems, construction of social infrastructure including water and sewage systems was recognized an urgent issue in 1996.

In particular, regional cities such as Sfax, the second largest city in Tunisia, and Kebili and Douz in the south shared the following issues: (1) Sewage has flowed into rivers and seeped into the ground from sewage tanks (called *Puis Perdu*) since ordinary households have not been connected to a sewage system, (2) due to the un-connection to the system mentioned in (1), groundwater and surface water was polluted, lowering the quality of water for agricultural use and drinking water as well as inducing environmental destruction in the city fringes, and (3) discharging untreated wastewater from ordinary households has deteriorated sanitary condition in urban areas. There was a concern that

[1] Consultation with the Tunisian government concerning the results of the preliminary evaluation took place in April 2009. The beneficiary survey was conducted during late April through early May 2009. The feedback seminar on the evaluation results was held in July 2009.

these shared issues would become increasingly severe, coupled with the high population growth rate in the regional cities.

Given the above concern, Tunisia's public sewage corporation, Office National de l'Assainissement (ONAS), which controlled sewage infrastructure, took steps to comprehend the cities' needs for sewage infrastructure by carrying out a sewage development demand survey in 199 cities with populations over 2,000 persons and by preparing a sewage master plan with the assistance of the World Bank. Based on the results, of the cities that had a strong need for sewage development in the above-mentioned survey and plan, four cities were selected as targets of this project. They were the three cities of Sfax, Kebili, and Douz, which had particularly high priority and were prepared to implement development smoothly. In addition, the city of Hammam Zriba, which was a target of investment for sewage development in the 8th National 5-Year Plan was included.

1.2. Project Objective

The objective of this project is to enhance the capacity of sewage treatment system by constructing and rehabilitating sewage treatment plants and sewage pipelines in 4 cities (Sfax, Kebili, Douz and Hammam Zriba) in Tunisia, thereby contributing to the improvement of living conditions of local residents and to the protection of environment in peripheral areas of each city.

1.3. Borrower / Executing Agencies

Government of the Republic of Tunisia / Office National de l'Assainissement (ONAS)

1.4. Outline of Loan Agreement

Loan Amount / Disbursed Amount	6,389 million yen / 6,386 million yen
Exchange of Notes / Loan Agreement	October, 1996 / December, 1996
Terms and Conditions	Interest Rate:2.5% (2.1% for Consulting Services) Repayment Period:25 years (Grace Period:7 years) Conditions for Procurement: General untied
Final Disbursement Date	April, 2006
Main Contactors (over 1 billion yen)	EPPM (Tunisia)・SOTUTRASM (Tunisia)・CHAABANE ET CIE (Tunisia) (JV) / GRANDS TRAVAUX MEGHAEITH (Tunisia)・ENVIRONNEMENT INDUSTRIE

	ET AMENAGEMENT (Tunisia) (JV)
Consulting Services (over 100 million yen)	N.A.
Feasibility Studies, etc.	1993 Sewage system development master plan for Sfax (by World Bank)

2. Evaluation Result (Rating: B)

2.1. Relevance (Rating: a)

The project has been highly relevant with Tunisia's development needs and national policies at the times of both appraisal and ex-post evaluation.

2.1.1. Relevance at Appraisal

While industrialization and tourism development were put at the center of economic development in the 8th 5-Year Plan (1992−1996), another priority issue in the plan was promotion of social infrastructure development including sewage systems, from the standpoint of correcting regional disparities and encouraging sustainable development that is environmentally sound. At the time of the appraisal, sewage development was the priority issue in overall national policy, and within that, four cities targeted by this project were prioritized in the demand survey[2] by ONAS and in the master plan[3] prepared with the assistance of the World Bank.

At the time in 1996, none of these cities except for Sfax had a sewage treatment plant, and the sewage from the existing sewage pipes was discharged untreated into nearby rivers, raising concerns about the impact on oasis agriculture in Kebili and Douz and about degradation of the image of the tourist city, Hammam Zriba. Even in Sfax which did have a sewage treatment plant, lack of sewage treatment capacity was a problem, making construction of a new treatment plant an urgent issue, to lighten the burden of the existing plant.

In view of the above, this project, which aims to boost the sewage treatment capacity of

[2] In the sewage development demand survey conducted by ONAS in 1992, 17 cities were selected as having a strong need for sewage development, based on criteria such as (1) investment efficiency indexes (i.e., investment amount per resident required for new sewage connections and the return on investment (ROI), (2) environmental considerations (related to public health such as groundwater pollution and offensive odors), (3) impact on tourism and agriculture, etc. Among these 17 cities, Kebili and Douz, which are two of the four target cities in this project, were included.

[3] A sewage development master plan was prepared in major five cities (Tunis, Sfax, Sousse, Kairouan, and Nefza) in 1993 with the assistance of the World Bank, bearing in mind the development of a systematic sewage system as outlined in the 9th National 5-Year Plan (1997-2001). Among these cities, Sfax thoroughly reviewed the old master plan prepared by ONAS in 1974, divided the city into three sections (northern, central, and southern), and planned to construct a new sewage treatment plant in the northern section. This project of Sfax's northern sewage treatment plant is consistent with Sfax's master plan.

each city by constructing new sewage treatment plants and promote resolution of multiple environment-related problems in the cities, may be deemed to have had high priority in order to resolve and support the development issues and development policy in Tunisia at the time.

2.1.2. Relevance at the time of ex-post evaluation

The 11th 5-Year Plan (2007-2011) sets forth development of water and sewage systems as a priority issue that should be addressed quickly from the standpoint of continued correction of regional disparities, improvement of living standards of local residents, and environmental conservation. Moreover, the most recent five-year plan mentioned above clearly states the following five points as the major policy goals related to sewage development: (1) expansion of the sewage network, (2) improvement of residents' living environment, (3) repair and expansion of old sewage-related facilities, (4) promotion of usage of treated sewage water, and (5) promotion of participation by the private sector in operation and maintenance.[4]

In the ex-post evaluation, high priority is placed on sewage development in the overall national policy. Moreover, the policy goal of utilization of PPPs (public-private partnerships) in repair and expansion of old facilities, promotion of recycling of treated sewage water, and operation and maintenance is wholly consistent with the content of this project, therefore this project is highly consistent with the sector policy.

In addition, there remains an extremely high need for sewage treatment and improvement of public health environment in the four cities targeted by this project. Particularly in Sfax, the demand for sewage treatment has nearly doubled[5] since the time of the appraisal due to the population growth[6]. If this project had not been implemented, it would be impossible for Sfax to cope with the current above-mentioned demand for sewage treatment, and it may be assumed that the city's public health environment would not have attained its current level (and exactly the same issue can be pointed out in the

[4] Specifically, it mentions (1) further spread of sewage service in urban areas and regional cities and prefectures (target connection rate in 2011: 91%), (2) improvement of the living environment of low-income residents, (3) improvement of the water quality of treated sewage water through the repair and expansion of old facilities as well as improvement of the quality of customer service through repair and expansion of the sewage pipe network, (4) further promotion and expansion of PPP (Public-Private Partnership) and BOT (Build, Operate, and Transfer) projects through strengthening of public-private collaboration, (5) promotion of increased usage of treated sewage water (by reducing the cost related to treated sewage water in the Tunis metropolitan area and in coastal areas and expanding delivery of water to regions where there is a demand (i.e., the central western and the southern regions), (6) continuation of study related to the action plan for recycling sludge and launch of specific action based on the results of the study, (7) promotion of construction of sewage treatment plants that specialize in industrial sewage treatment, and through that, achievement of drastic improvement in the management of industrial wastewater, and (8) improvement of the financial status of ONAS.

[5] From approximately 15,000 ㎥/day in 1997 to approximately 34,000 ㎥/day in 2007 (source: ONAS).

[6] In 1996 when the appraisal was conducted, the population was 430,000, and in 2007, it had increased to approximately 500,000 (an increase of approximately 16%) (Source: same as above).

other three cities which did not possess sewage treatment plants). On the other hand, considering the fact that the rate of population growth remains lower (discussed below in the section on "Effectiveness") and that the demand per person for water is approximately half of the amount compared to the projection at the time of appraisal, the future need for sewage treatment is expected to grow more slowly than planned.

Each component of this project discussed below is tailored to the actual conditions and issues mentioned above. The sewage-related facilities built by this project (sewage treatment plants, sewage networks, etc.) meet the demand for sewage treatment in the four target cities as the only infrastructure facilities for sewage treatment operations.

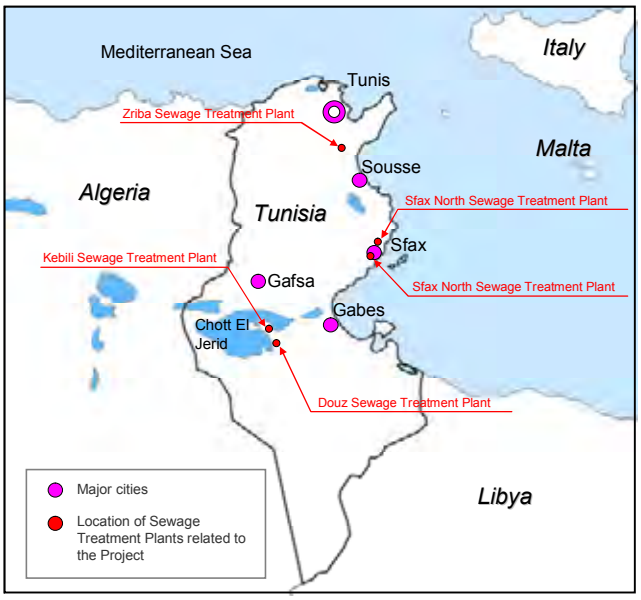


Figure-1: Location of Project Sites

2.2. Efficiency (Rating: b)

The actual cost was lower than planned whereas the project period was much longer than planned (217% of the original plan); therefore the evaluation for efficiency is fair.

2.2.1. Outputs

The table below presents a comparison of the planned output and the actual output. In addition to the significant increase in the treatment capacity of the Sfax Sewage Treatment Plant (North), the area covered by sewage pipes was extended in all cities except Hammam Zriba. Moreover, in terms of the materials and machinery procured for operation and maintenance, the number of the items procured increased by approximately 30%. The main reasons for changes in each output are as follow.

Table-1: Changes in Output

Project Components	Original	Actual	Differences
1. Sfax			
1.1 Construction of new plant (North)	Design capacity: 10,000m^3/day	17,900m^3/day	7,900 m^3/day (+)
1.2 Expansion of existing plant (South) Design capacity: 24,000m^3/day (before rehabilitation)	Design capacity: Doubling the existing plant	49,500m^3/day (after rehabilitation)	Mostly as planned
1.3 Construction of sewage pipelines	Total length: 156.5km	289km	132.5km (+)
1.4 Construction of pumping stations	11 stations	9 stations	2 stations (-)
2. Kebili			
2.1 Construction of new plant	Design capacity: 3,130m^3/day	3,110m^3/day	Mostly as planned
2.2 Construction of sewage pipelines	Total length: 29.6km	36km	6.4km (+)
2.3 Construction of pumping stations	2 stations	3 stations	1stations (+)
3. Douz			
3.1 Construction of new plant	Design capacity: 4,700m^3/day	4,700m^3/day	As planned
3.2 Construction of sewage pipelines	Total length: 36.7km	62km	25.3km (+)[1)]
3.3 Construction of pumping stations	2 stations	2 stations	As planned
4. Zriba			
4.1 Construction of new plant	Design capacity: 2,000m^3/day	1,800m^3/day	200 m^3/day (-)
4.2 Construction of sewage pipelines	Total length: 6.6km	7.0km	Mostly as planned
4.3 Rehabilitation of sewage pipelines	Total length: 6.5km	7.0km	Mostly as planned
4.4 Construction of pumping stations	4 stations	4 stations	As planned
5. Operation and maintenance equipment (High-pressure washer trucks for cleaning pipes, Vehicles with investigative cameras, Business vehicle, Other equipment)	51 items in total (High-pressure washer trucks (15), Vehicles with cameras (1), Business vehicles (24), Other equipment (11 items))	68 items in total High-pressure washer trucks (17), Vehicles with cameras (3), Business vehicle (44), Vaccuum machine (4)	17 items (+)
6. Consulting Services (C/S)	30 M/M	34.57 M/M[2)]	4.57 M/M (+)

Source: JICA internal documents and results of interviews

Note 1): Total length of 10km, out of 25.3km, is the additional output which connected Douz Sewage Treatment Plant and sewage network in Golaa (the neighboring district of Douz).

Note 2): 31.57 M/M out of 34.57 M/M is for consulting service of Sfax component while 3 M/M out of 34.57 M/M was for that of environmental impact assessment on Chott El Jerid.

Note 3): (+) and (-) are, respectively, indicating the increase and decrease compared to the original plan.

✓ Sfax project component: The significant increase in the treatment capacity of the Sfax Sewage Treatment Plant (North) (10,000m^3/day → 17,900m^3/day) was a result of the decision to include central Sfax in the treatment target area at the detailed design (D/D) stage to cope with the expected increase in population. The significant expansion of the area covered by sewage pipes (156.5 km→289 km) was due to the above-mentioned expansion of the target area. Moreover, the reduction in the number

of pumping stations (from 11 to 9) was made accompanying reconsideration of placement of the sewage network.

- ✓ Kebili project component: The extension of the sewage pipes (29.6 km→36 km) was carried out to expand the sewage pipe network in keeping with Kebili's city development plan designed in 2006. The increase in the number of pumping stations (from two to three) was necessitated by the above-mentioned extension of sewage pipes.
- ✓ Douz project component: The extension of sewage pipes (36.7 km→62 km) was carried out to (1) further expand the sewage pipe network in the city of Douz (approximately 15 km) and (2) connect sewage pipes from Golaa area to the Douz Sewage Treatment Plant.[7]
- ✓ Hammam Zriba project component: The reduction in the treatment capacity of the sewage treatment plant (2,000m^3/day → 1,800 m^3/day) was carried out in response to actual sewage treatment demand which was ascertained in the detailed design (D/D) stage. (The figure of 2,000m^3/day was obtained in the small-scale feasibility study conducted prior to the start of the project.)
- ✓ Purchase of operation and maintenance equipment: The reason for the increase in the high-pressure washer trucks for cleaning sewage pipes, vehicles with investigative cameras, and business vehicles was increase of the operation and maintenance area accompanying the extension of the sewage network (due to additional output and other construction). The new purchase of suction equipment (total of 4) used for draining rainwater, etc., was to provide better service in operation and maintenance activities.[8]
- ✓ Consulting service (C/S): The increase in the amount spent on consulting service in Sfax (24 M/M→31.57 M/M) was due to the delay in implementation at the Sfax Sewage Treatment Plant (South) as mentioned below, which was to be carried out at the same time of the Sfax Sewage Treatment Plant (North). The time lag of implementation between the two plants required to increase the M/M for the civil engineering specialist (team leader) who supervised both components.

2.2.2. Project period (Rating: c)

The project period was much longer than planned.

The project was scheduled from January 1996 to December 2000, a period of 60

[7] Because there was no sewage treatment plant in the Golaa area and there was concern about environmental degradation in the area due to untreated wastewater discharge, it was decided to lay additional sewage pipes (source: ONAS).

[8] The 11 pieces of machinery and materials scheduled for procurement (listed as "Other machinery and materials" on Table 1) were not procured, and in their place were ordered high-performance equipment such as small-size suction equipment and vehicles with investigative cameras (source: ONAS).

months, but it extended to 130 months, from January 1996[9] to October 2006[10], which was equivalent to 217% of the original plan[11].

The main factor causing the delay was the significant setback in the Sfax component because it was the critical path for the entire project. Specifically, the two points to be mentioned are (1) the significant delay in the selection of the detailed design (D/D) consultant (procured by World Bank funds, separate from this project) for the Sfax Sewage Treatment Plant (North), which construction (expansion of treatment capacity from 10,000 m^3/day to 17,900 m^3/day) was under the project loan and (2) the delay caused by the repeat of the bidding on repair work for the Sfax Sewage Treatment Plant (South).

Against the above backdrop, the contractor agreement for the Sfax Sewage Treatment Plants (North and South) lingered on until September 2003. This resulted in a delay of 64 months (5 years 4 months) from June 1998, which was the scheduled date at the time of the appraisal. As a result, the delay until the end of the contractor agreement was the direct cause of the significant delay of the entire project.

Table-2: Comparative Table of Project Periods

Task	Original Schedule（months）	Actual (months)	Differences (months)
Tender Preparation	Jan.1996 - Dec.1997 (24.0)	Jan.1996 - Feb.2001 (62.0)	38.0
Tender / Evaluation / Contract	Mar.1997 - Jun.1998 (16.0)	Jan.1997 - May.2005 (101.0)	85.0
Land Acquisition	Oct.1996 - Dec.1997 (15.0)	Apr.1997 - Jan.2002 (58.0)	43.0
Civil Works	Oct.1997 - Sep.2000 (36.0)	Nov.1997 - Oct.2006 (108.0)	72.0
Consulting Service	Oct.1997 - Dec.2000 (39.0)	Dec.2002 - Oct.2006 (46.0)	7.0

Source: JICA internal documents, answers to the questionnaire to ONAS and results of interviews

2.2.3. Project cost (Rating: a)

Total project cost was lower than planned (99% of the original plan).

The total cost of the project was originally 8,518 million yen (the Japanese ODA loan share was 6,389 million yen) but the actual project cost was 8,436 million yen (the Japanese ODA loan share was 6,386 million yen), which was equivalent to 99% of the original plan. As shown in the Comparison of Original and Actual Scope which appears at

[9] While the signing of the loan agreement took place in December 1996, preparation for the Kebili bidding was started in January 1996 by ONAS. According to ONAS, preparation for bidding (preparation of bidding documents, etc.) was executed prior to the loan agreement signing in order to save time because it had been instructed by JICA (the Former Japan Bank for International Cooperation (JBIC)) that "implementation of bidding prior to the loan agreement signing is impossible" . Therefore, it is appropriate to consider January 1996 as the start of the project (e.g., the starting date of practical work related to the project).

[10] The completion date of the project is defined as preliminary acceptance date for transference of the facilities constructed at the Sfax sewage treatment plant (south) (Source: Answers to the questionnaire to ONAS and results of interview with ONAS).

[11] The loan disbursement deadline was extended twice (in March 2002 and May 2005) in this project, a total of four years.

the end of this report, foreign currency portion significantly declined and local currency portion significantly increased. According to the interview with ONAS, the cause was that "at the time of appraisal, a large foreign currency portion was estimated because it was assumed that most of the project contractors would be foreign companies, but it turned out that most of the contractors were Tunisian companies, which caused payments in local currency to expand more than initially anticipated."[12]

2.3. Effectiveness (Rating: b)

Among five operation and effect indicators (population treated, percentage of population served, rate of wastewater treated, Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS)) that can be compared with a target value, some of them have not achieved the target as planned. On the other hand, many positive impacts were recognized. Therefore, this project has produced certain effects, and its effectiveness is fair.

2.3.1. Quantitative effects - Operation and Effect Indicators

(1) Population treated and percentage of population served

Shown on the table below are the base level (1996), achieved level (2007), and target level (2011) for the population treated and the percentage of population served in the project target areas (a total of five cities and areas including Sfax North, Sfax South, Kebili, Douz, and Hammam Zriba). Whereas Kebili and Hammam Zriba have achieved 94% of the 2011 target level, Sfax (North and South) and Douz have reached only 60% to 70%. Given that there remain only four years until 2011, achievement of the target in these two areas is expected to be somewhat difficult.

The reason why the growth of population treated is lower than expected is due to the low percentage of population connected. There are many possible reasons as to why the percentage of population connected is low, such as topographical factors and Tunisian social customs, etc., but the main reason that is frequently pointed out is that "the sewage connection fee for which ONAS charges contracting households is extremely high given the disposable income[13] of ordinary households in Tunisia." (The fee is 260 Tunisian dinars, equivalent to approximately 20,000 yen.)[14]

To improve the percentage of population served, it would be desirable to implement measures such as further expansion of connection fee discount schemes (currently, low

[12] Source: Result of interview with ONAS.
[13] Gross national disposable income per capita in 2008 in Tunisia was 4,912 dinars (approximately 370,000 yen, annually) (source: Tunisia's National Statistics Institute).
[14] Source: Interviews with ONAS and JICA senior volunteers in Tunis (sewage specialists) and JICA's internal material, etc.

income earners are charged 130 Tunisian dinars, which is half of the regular fee) and further expansion of the sewage network.

Table-3: Population Treated

Unit: people

Cities/Area	Baseline (1996)	Actual (2007)	Target (2011)	Achievement Ratio
Sfax North	Unknown	38,829	62,530	62%
Sfax South	Unknown	299,843	395,420	76%
Kebili	7,725	17,663	18,850	94%
Douz	0	23,254	31,800	73%
Zriba	6,102	8,964	9,530	94%

Source: Prepared from JICA internal documents and data received from ONAS

Note 1): Achievement ratio is calculated from the current value of 2007 divided by the target value of 2011

Note 2): Population treated = Number of households connected to sewage services * Number of people per household

Table-4: Percentage of Population Served

Unit: %

Cities/Area	Baseline (1996)	Actual (2007)	Target (2011)	Achievement Ratio
Sfax North	30	43.0	65.0	66%
Sfax South	Unknown	73.5	91.0	81%
Kebili	45[3)]	91.0	92.0	99%
Douz	Approx.0[3)]	65.5	84.8	77%
Zriba	80[3)]	95.4	95.8	Approx.100%

Source: Prepared from JICA internal documents and data received from ONAS

Note 1): Achievement ratio is calculated from the current value of 2007 divided by the target value of 2011

Note 2): Percentage of population served = Population treated / Total population of the area

Note3): Baseline as of 1994 (Source: JICA internal documents)

(2) Rate of wastewater treated and rate of facility utilization

As shown on Table 5 below, the rate of wastewater treated at each treatment plant as of 2007 was low compared to the maximum treatment capacity (at Sfax North, Sfax South, Kebili, Douz, and Hammam Zriba, the figures were 31%, 57%, 67%, 40%, and 19%, respectively, and these figures also represent the rate of facility utilization). ONAS states that "the maximum treatment capacity of each sewage treatment plant is designed to cope with the demand in 2016." According to this statement, the rate of wastewater treated and the rate of facility utilization are increasing basically as expected at the treatment plants in Sfax South and Douz, which have been in operation since 2004, and in Kebili, which currently has a utilization rate of 67% (see Figure 2 below for details). Meanwhile, the rates of facility utilization in 2007 of the treatment plants in the Sfax North and Hammam Zriba were 5% and 17% lower than the standard to be achieved, respectively.[15]

[15] According to JICA's internal materials, the 2011 target level for the rate of facility utilization of Sfax North and Sfax South is 100%, but ONAS states that "100% will be achieved in 2016." Because completion of the facilities was delayed by five to six years compared to the original schedule, it is likely that ONAS reset the target year.

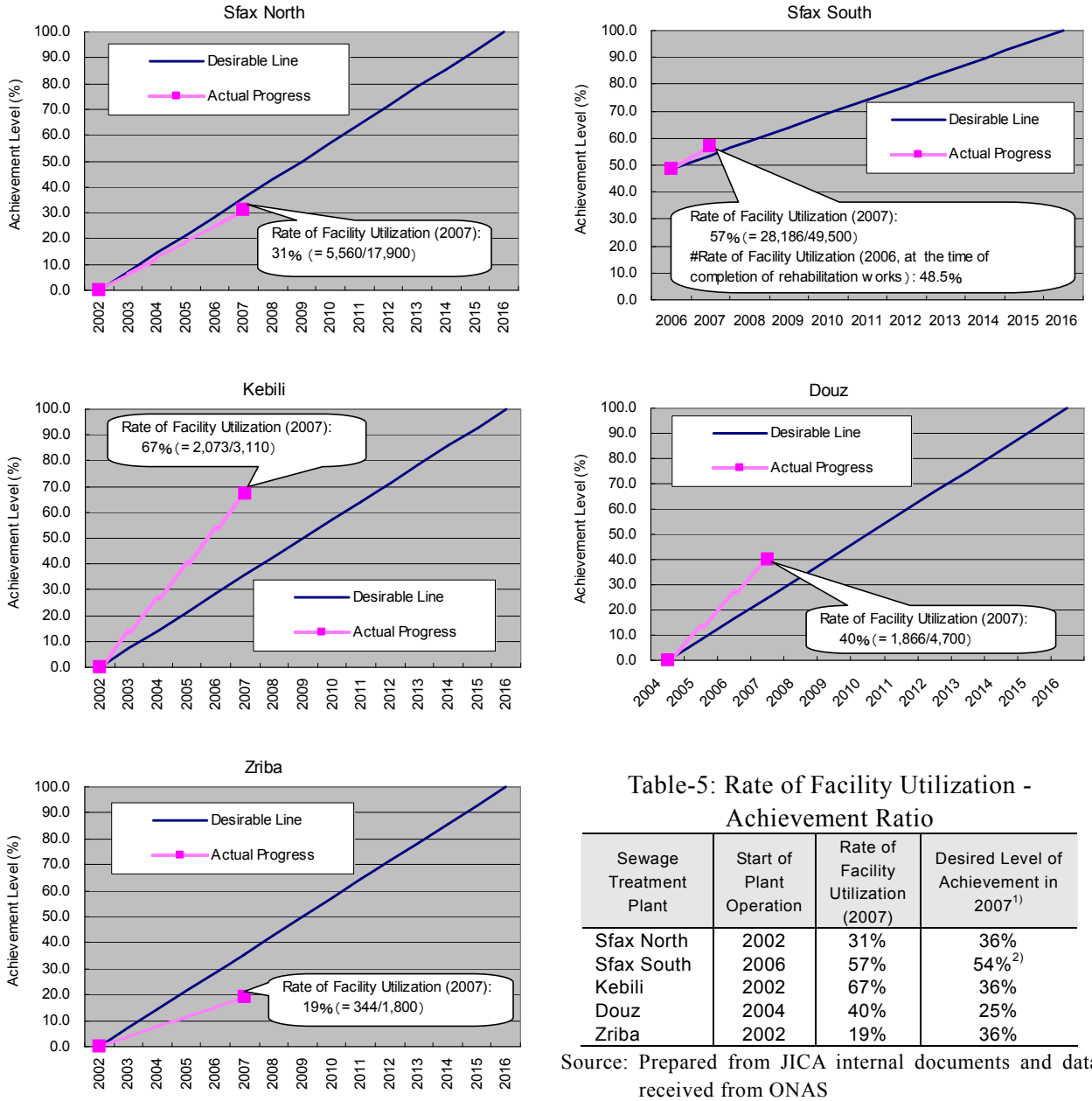


Table-5: Rate of Facility Utilization - Achievement Ratio

Sewage Treatment Plant	Start of Plant Operation	Rate of Facility Utilization (2007)	Desired Level of Achievement in 2007[1)]
Sfax North	2002	31%	36%
Sfax South	2006	57%	54%[2)]
Kebili	2002	67%	36%
Douz	2004	40%	25%
Zriba	2002	19%	36%

Source: Prepared from JICA internal documents and data received from ONAS

Figure-2: Comparison of Desirable and Actual Rates of Facility Utilization

Source: Prepared from JICA internal documents and data received from ONAS

Note 1): The calculated (desired) level of facility utilization rate in 2007, supposing that the rate of facility utilization will reach 100% in 2016 and it will continue to increase at the same pace every year, from the commencement of plant operation until 2016.

Note 2): Assumed that the rate of facility utilization in 2006 achieved 48.5% (＝24,000/49,500) since Sfax Sewage Treatment Plant (South) had the capacity of 24,000 ㎥/day before the rehabilitation works.

Note 3): Rate of facility utilization＝ The amount of wastewater treated (daily average) / Treatment capacity of the plant

Since the amount of sewage produced is proportional to the amount of water used, it is necessary to consider amount of water used per person, which greatly impacts on the rate

of wastewater treated and the rate of facility utilization.

Table 6 below shows the forecast demand and actual demand per person for water at the time of the appraisal. The forecast at the time of the appraisal predicted a demand as 92 to 128 liters/day/person in 2011 in the project's four target cities. However, the actual demand in 2007 was only about half of the prediction.[16] It has been pointed out that the reasons for the low growth in water usage per person include the quality of the water (high salt content) and the water-saving campaign, etc. promoted by the Tunisian government as a part of national policy.[17]

Table-6: Forecast and Actual Demand per Person for Water

Unit: liter/day/person

Cities/Area	2001	2007	2011
Forecast demand at the time of project appraisal (forecasted in 1996)			
Grand Sfax	117[1)]	123	128
Kebili	90	-	100
Douz	100	106	110
Zriba	76	-	92
Actual demand			
Average Demand of 4 Cities in Total	-	Approx. 50-60	N.A.
National Average	-	Approx. 90	N.A.

Source: JICA internal documents (for forecast demand) and ONAS (for actual demand)

Note 1): Data in 2002

Note 2): "—" means data is not available.

Note 3): Actual demand per person for water in Tokyo Metropolitan Area (in 2007) is 239 liter/day. (Source: Bureau of Waterworks, Tokyo Metropolitan Government)

Regarding the low rate of facility utilization in Hammam Zriba, it has been pointed out that, in addition to the above reasons, wastewater from hot springs was expected to compose part of the rate of wastewater treated, but because part of the hot spring area was excluded from the project, wastewater from that excluded area does not flow into the current sewage network.[18]

(3) Achievement of Emission Standards for Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS, MES)

As shown on Table 7, the standards for both BOD and TSS (MES) are being met at Sfax North, Kebili, and Douz, but Sfax South and Hammam Zriba are not meeting the emission standard (of 30 mg/liter).

The surrounding area of the Sfax Sewage Treatment Plant (South) is an industrial zone. Companies with factories in Tunisia are required to either (1) set up their own wastewater treatment plant, treat the discharge in order to meet the effluent standards, and directly

[16] This is lower than the 90 liters/day which was the national average in that year.
[17] Source: Results of interview with ONAS.
[18] Source: Same as above.

release it into rivers, etc., or (2) treat the wastewater at a required level at the plant and release it into the sewage pipes. However, there are said to be many factories in this area without their own wastewater treatment plants, and they release large amount of industrial wastewater that greatly exceed the standards into sewage pipes.[19] Thus, the quality of the sewage water flowing into the treatment plant is originally poor, and many experts point this out as the main cause of the poor quality of the discharge from the treatment plant.[20]

Table-7: BOD and TSS for Each Sewage Treatment Plant (Average Data in 2007)

Unit: mg/liter

Sewage Treatment Plant	Influent Quality	Effluent Quality	Rate of Removal	Below/Over the National Standard
BOD (Biochemical Oxygen Demand)				
Sfax North	544	29	95%	Below Standard
Sfax South	574	40	93%	Over Standard
Kebili	309	21	93%	Below Standard
Douz	168	17	90%	Below Standard
Hammam Zriba	424	33	92%	Over Standard
National Standard / National Average		30 / 41		
TSS (Total Suspended Solids)				
Sfax North	622	27	96%	Below Standard
Sfax South	609	45	93%	Over Standard
Kebili	498	17	97%	Below Standard
Douz	338	23	93%	Below Standard
Hammam Zriba	348	44	87%	Over Standard
National Standard / National Average		30 / 45[1)]		

Source: Prepared from JICA internal documents and answers to the questionnaire to ONAS

Note 1): National average data in 2006 (Source: JICA (2009) *Ex-Post Evaluation of Treated Sewage Irrigation Project*, pp10.)

Note 2): National standard in Japan - BOD: 20 mg/liter, TSS: 25 to 50 mg/liter (depends on rivers and lakes)

As the reason why the quality of the discharge at the Hammam Zriba Sewage Treatment Plant does not meet the standards, ONAS states that "the rate of wastewater treated is extremely small compared to the treatment capacity, and the quality of the incoming water is low."

Furthermore, Tunisia's national averages (2007) for both BOD and TSS (MES) were originally 41 mg/liter and 45 mg/liter, respectively, which fall short of the emission standard of 30 mg/liter. Therefore, the water discharged from all the sewage treatment plants in this project is either equal to or below the national average.[21]

2.3.2. Qualitative effects

Recycling of Sludge Produced

The sludge produced at the sewage treatment plants is not being recycled in the four treatment plants of Sfax North, Sfax South, Kebili, and Douz (see the section on "Impact"

[19] Source: Results of interview with ONAS (and it is also consistent with the trend shown in Table 6).

[20] Source: Interviews with multiple engineers at ONAS and with JICA senior volunteers (sewage specialists) in Tunis.

[21] The emission standards in Tunisia are strict and are the same as in Japan (see Note 2 of Table 7).

below for details; also, the plant in Hammam Zriba uses the natural lagoon treatment method which does not produce sludge). Research on effective usages of sludge is currently being conducted through the cooperation of three bodies, the Ministry of Agriculture, Ministry of Health, and ONAS. As a part of the research, verification tests are planned in Kebili and Douz.[22]

Recycling of sludge has hardly moved beyond the planning stage yet, but at the same time, according to the results of the beneficiary survey,[23] a very large number of farmers showed expectations for usage of sludge (52 out of 83 farmers hope to recycle sludge), and so the results of the verification tests, etc., by the three bodies are eagerly awaited.

Moreover, as already stated under "Relevance," national studies related to recycling of sludge are currently going on under the 11th 5-Year Plan, and there are plans to prepare a specific action plan during this five-year period. In the medium to long term, promotion of sludge recycling can be anticipated, and it may be surmised that the following trends related to this project will accelerate in the future.

2.3.3. Financial Internal rate of return (FIRR)[24]

The financial internal rate of return (FIRR) was recalculated using the terms and conditions on the table below as the base scenario. A sensitivity analysis was also conducted on the recalculated FIRR value, taking the sewage charge as a parameter and assuming two cases, one slightly more pessimistic than the base scenario (scenario-1) and another slightly more optimistic (scenario-2). The table below shows the results of the recalculation.

The recalculated FIRR value was negative (minus 9% in the case of the base scenario). There are two conceivable reasons: (i) the population growth rate in the target cities was significantly lower than assumed at the time of the appraisal, and so the revenue from sewage charge was lower than initially assumed, and in addition, and (ii) sewage charge system remained extremely lower than initially expected (because it is politically difficult to raise the charges). (Given that these two reasons are considered to be external factors that the implementing agency cannot control, the recalculated FIRR was not included in the evaluation of "Effectiveness".)

---

[22] Source: Results of interview with ONAS.

[23] Outline of beneficiary survey: The survey consisted of face-to-face interviews with 263 persons and companies, including ordinary residents (110 persons in all the four target cities), local companies (22 companies in Sfax South only), agricultural workers (89 workers in all the four target cities), and tourism workers (42 workers in Douz and Hammam Zriba only) in the cities and regions of Sfax, Kebili, Douz, and Hammam Zriba

[24] Furthermore, the economic internal rate of return (EIRR) was not calculated due to limited resources for this study because it would have been necessary (1) to grasp, through individual interviews, input data from the beneficiary side, such as the target area residents' WTP (Willingness to Pay) for water quality improvement and (2) to convert into monetary terms the environmental value of the effect of improving the water quality in public waters (i.e., agricultural water sources, etc.).

Table-8: Recalculation of FIRR

Timing	Preconditions and Assumptions for Recalculation (Project Life: 15 years after the completion of the Project for each case)[25]	FIRR
At the time of Appraisal (in 1996)	Costs: Civil works cost, consulting service cost, land acquisition cost, physical/price contingency, operation & maintenance cost (which assumed as 1% of the total project cost) Benefits: Revenue from sewage charges (assuming 15% increase every year up to 2000 and 10% increase every year after 2001, average charge in 1997 is 1.5 Tunisia Dinar per 1 ㎥ per household.)	7%
At the time of ex-post evaluation (in 2009)	**Base Scenario** Costs: Civil works cost, consulting service cost, operation & maintenance cost (which applies actual cost until 2007, then decreases by half every 5 years after 2008, due to the introduction of PPP) Benefits: Revenue from sewage charges (assuming 6% increase in 2009 and 5% increase every two years after 2010, average charge in 2008 is 0.427 Tunisia Dinar per 1 ㎥.)	Minus 9%
	Scenario-1 (pessimistic than base scenario) Costs: The same with base scenario Benefits: Revenue from sewage charges (assuming 6% increase in 2009 and remaining the same level after 2010)	Minus 10%
	Scenario-2 (optimistic than base scenario) Costs: The same with base scenario Benefits: Revenue from sewage charges (assuming 6% increase in 2009 and 15% increase every two years after 2010	Minus 5%

The results of the sensitivity analysis were minus 10% for scenario-1 and minus 5% for scenario-2. Scenario-2 is the case which takes an extremely optimistic view of the size of hikes in sewage charges, but even so FIRR value remained negative. In order to improve the profitability of the project, it is necessary to institute a substantial fee hike, increase the percentage of population connected, and gradually decrease the operation and maintenance costs.

2.4. Impact

It is very much difficult to observe the medium- to long-term impacts (ex. accelerated regional development due to the improvement in the peripheral areas of target cities) because only two years and four months have passed since the project completion and we are still in the build-up period of such impacts. Given these considerations, results of beneficiary surveys (social impact assessment) were mainly referred to when evaluating the “Impact”.

2.4.1. Improvement of sanitation in residents’ housing and living environment (in the four cities overall)

As shown on the table below, the number of beneficiaries who perceived some sort of problem in the housing or living environment dropped approximately by half after

[25] Incidentally, if the project life is set at 20 years, then FIRR value is minus 3% in the base scenario, minus 5% in scenario-1, and 1% in scenario-2.

installation of a sewage connection in comparison to before the installation.

Problems such as foul odors and outbreaks of insects have not been completely resolved (the main cause of the foul odor, however, is thought to be the low level of the percentage of population connected, as mentioned above), but it may be concluded that implementation of this project produced a certain amount of environmental improvement effect.

Table-9: Improvement on Living Conditions before and after the Connection to Sewer

(N=218)

Type of Beneficiaries	No. of Respondents in Total	Before connection to sewer: Beneficiaries who felt problems[1)]		After connection to sewer: Beneficiaries who still feel problems[2)]	
		No. of Respondents	% of Total	No. of Respondents	% of Total
Local Residents	110	84	76%	47	43%
Farmers[3)]	44	38	86%	25	57%
Private Companies	22	14	64%	2	9%
Tourism Workers	42	36	86%	14	33%
Total	218	172	79%	88	40%

Source: Results of beneficiary survey

Note 1): The number of beneficiaries who answered "there were some problems before connecting to the sewer"

Note 2): Among the above respondents (who perceived some sort of problem before connection), the number of beneficiaries who answered "there are still some problems even after connecting to the sewer"

Note 3): 45 farmers, out of 89 farmers who participated in the beneficiary survey, are excluded from this question because they have not yet connected to the sewer.

Table-10: Breakdown of the Problems Answered by Beneficiaries (Multiple Answers)

Type of Beneficiaries	Before connection to sewer: Beneficiaries who felt problems			After connection to sewer: Beneficiaries who still feel problems		
	Malodour	Insects	Others[1)]	Malodour	Insects	Others[2)]
Local Residents	57	30	56	36	13	20
Farmers	23	18	47	18	6	16
Private Companies	7	2	5	1	1	0
Tourism Workers	30	27	18	10	7	13
Total	117	77	126	65	27	49

Source: Results of beneficiary survey

Note 1): Contamination of surface water, soil pollution, salt pollution on surface water, etc.

Note 2): High sewage connection charge, low connection rate to sewer, etc.

2.4.2. Environmental conservation of peripheral area through sewage treatment

(1) Environment conservation of farmland in Sfax North, Kebili, Douz, and Hammam Zriba

According to the Table-11, approximately 60% of all farmers (48 out of 83) perceived some sort of problem in the farmland environment (contamination of surface water, insects, foul odor, etc.) prior to the implementation of the project. However, approximately 90% of the 48 farmers who had perceived the problem responded that "the farmland environment has been improved" following implementation of the project (see the Table-12). That is to say, it may be concluded that the farmland environment

surrounding the project site was significantly improved by the implementation of the project.

Table-11: Conditions of Farmland before the Project (N=83)

Answers from Farmers	No. of Respondents	% of Total
There were some problems around the farmland. [1)]	48	58
There were no problems around the farmland	23	28
Don't know / No answers	12	14
Total	83	100

Source: Results of beneficiary survey

Note 1): Breakdown of the problems: i) Contamination of surface water, ii) Outbreak of insects, iii) Malodour, iv) Soil pollution, v) Pollution on agricultural crops, etc.

Note 2): 83 respondents in total (6 out of 89 did not answer to the question.)

Table-12: Conditions of Farmland after the Project (N=48)

Answers from Farmers	No. of Respondents	% of Total
Environmental problems have largely been solved.	19	40
Environmental problems have been solved to some extent.	23	48
No changes between before and after the project.	1	2
Don't know / No answers	5	10
Total	48	100

Source: Results of beneficiary survey

Note): Giving this question to 48 respondents who answered "there were some problems around the farmland before the project" (see Table-11).

(2) Environment improvement of surrounding rivers

Discharge of untreated sewage into River El Melah and Chott El Jerid (the largest saltwater lake in northern Africa which is also the final discharge site of sewage) in Kebili and Douz was reduced to some extent by implementation of this project, and as a result, environmental improvement has been recognized in the river and lake.[26] Likewise in Hammam Zriba, it was stated in an interview with ONAS that "because discharge of untreated sewage into River El Hammam was reduced to some extent, environmental improvement can be recognized in the river."[27]

Prior to the project, all types of sewage from Kebili, Douz, and Hammam Zriba were discharged untreated into surrounding rivers and the saltwater lake. Given the significant improvement in the quality of the untreated sewage due to the construction of sewage treatment plants, it may be concluded that environmental improvement effects are being expressed (one example of which is the improvement in the water quality of the inflow and discharge of BOD and MES, as stated in the section on "Effectiveness").

[26] Answers to the questionnaire to ONAS and results of interviews at ONAS's Kebili regional office.
[27] Answers to the questionnaire to ONAS and results of interviews at ONAS's Zaghouan regional office.

2.4.3. Expansion of irrigation by recycling treated sewage water

The irrigation area has been expanded in some areas (Sfax South) by recycling treated sewage water. As shown on the table below, similar plans are progressing in other cities (as of April 2009, Sfax North had plans for irrigation).

Given the historical circumstances[28] of Tunisia with relation to usage of treated sewage water, application of the water for irrigation in the four cities is expected to increase in the future. In the long term, there is a high potential for expression of the impact of the project in improvement in agricultural productivity.

Table-13: Irrigation by Reuse of Treated Wastewater

Cities/Area	Irrigated Area[1)] (As of April 2009)	Target Area	Rate of Reuse of Treated Wastewater[2)3)] (2008)
Sfax North	0 ha	400 ha	N.A.
Sfax South	537 ha	1,000 ha	23%
Kebili	0 ha	Under review	Approx. 20%
Douz	0 ha	Under review	N.A.
Total	537 ha	1,400 ha	-

Source: Results of interview with ONAS

Note 1): Total irrigated area by treated wastewater (in Tunisia) is approx. 8,000 ha. (Source: Results of interview with Ministry of Agriculture)

Note 2): Rate of reuse of treated wastewater varies from year to year because it highly depends on rainfall fluctuation. (Incentives for the utilization of treated wastewater will decline if there is a large amount of rainfall.)

Note 3): The target rate of reuse of treated wastewater set by Tunisian government is 35%. (Source: ONAS)

Note 4): The crops cultivated at irrigated area in Sfax South are mainly fodder ones. (Source: Results of interview with Ministry of Agriculture)

2.4.4. Impact on natural and social environment

(1) Environmental impact

Aside from the foul odor and outbreak of insects pointed out by residents, no particularly serious problems have occurred with regard to negative impact on the environment.[29]

The foul odor, as mentioned above, improved considerably following the implementation of the project, but some residents still state that they are dissatisfied. However, it seems unlikely that the main source of the foul odor is the sewage treatment

[28] In Tunisia where rainfall is sparse, difficulty in securing irrigation water for farming during the dry season is the largest bottleneck in improvement of agricultural productivity. Given this circumstance, attention turned long ago to usage of treated sewage water, and the government began agricultural irrigation using treated sewage water in 1965. As a result of long years of research on the safety and usage methods of treated sewage water, the government issued a presidential order concerning recycling of treated water in 2006 and formally took the stance that there was no problem with the safety of treated water. Taking this as an opportunity, the Ministry of Agriculture and ONAS accelerated their collaboration on usage of treated sewage water (source: interview at the Ministry of Agriculture). Crops for which usage of treated sewage water is permitted are (1) crops for animal feed, (2) flowers, and (3) tobacco, etc. In addition to crop, treated sewage water is used on tree farms and golf courses, etc. (source: same as above).

[29] Adjacent to the Sfax Sewage Treatment Plant (South) is an extensive phosphorous storage site and a waste disposal site. At the current time, no negative environment impact from the storage site or the disposal site on the treatment plant has been confirmed.

plants because (although it is not the case that the treatment plants produce absolutely no odor) the five sewage treatment plants, which were constructed or repaired by this project, are located at a distance of several kilometers from the city centers and the nearest houses are at least 500 meters away. Meanwhile, as stated under "Effectiveness," the percentage of population connected remains low in each city. Because of the effect, there is a high possibility that the main source of the foul odor is the sewage tanks (called *Puis Perdu*) still used by households not connected to a sewage system. It is desirable for ONAS to make further efforts to increase the percentage of the population connected.

(2) Recycling of sludge

The current state of sludge treatment is shown on the table below. None of the treatment plants carries out recycling, which is still in the planning stage (as stated under "Effectiveness").

Table-14: Recycling of Sludge at Sewage Treatment Plant

Sewage Treatment Plant	Sludge Produced (Dry weight base)	Current State of Sludge Treatment
Sfax North	500 ton/year	Dried, then stored at the plant site
Sfax South	2,000 ton/year	Dried and mechanically dewatered, then stored at the plant site
Kebili	0.96 ton/year	Stored at the plant site
Douz	0.08 ton/year	Stored at the plant site
Zriba	N.A.	No sludge produced. (lagoon treatment process)

Source: Answers to the questionnaire to ONAS and results of interview with ONAS

Currently, a basic study is being conducted on reuse of sludge nationwide in Tunisia by funds from Germany's KfW Bankengruppe. The safety and specific usage method for recycling (at the current time, distribution to farmers and recycling as concrete aggregates is under study) is being analyzed and studied, and the final report is to be submitted in 2011.[30] Moreover, separate from the above-mentioned study, ONAS is currently launching a nationwide pilot project involving recycling of sludge (however, this project's four target cities are not included).

ONAS plans to make the final decision on sludge recycling methods once it receives the results of the KfW study and the pilot project. A law related to sludge recycling was enacted in Tunisia in 2002, completing the preparation of the legal system for recycling.(The above-mentioned pilot project began following the passage of this law.)

(3) Implementation status of Environmental Impact Assessments (EIA) and environmental monitoring

The table below shows the implementation of environment impact assessments (EIA)

[30] Source: Results of interview with ONAS.

by ONAS and approval by Agence Nationale de Protection de l'Environnement (ANPE). In three cities (encompassing four sewage treatment plants) excluding Hammam Zriba, EIAs were implemented prior to the start of the project, and the results were approved by ANPE. It appears that each type of environmental monitoring was implemented during the construction period of each sewage treatment plant.

Table-15: Environmental Impact Assessment (EIA) and Approval by ANPE

Project Component	Implementation of EIA	Approved by ANPE
Sfax (North & South)	Completed before the project	Approved
Kebili	Completed in May 1996	Approved
Douz	Completed in May 1996	Approved

Source: JICA internal documents and results of interview with ONAS
Note): No data about Hamman Zriba

Currently, periodic environmental monitoring is conducted at the sewage treatment plants and treated sewage discharge sites, including at Sfax South around the discharge waterway which empties into the Mediterranean Sea. (Water quality inspections are conducted 5 to 11 times per month. The items measured include BOD, etc.) Systematic environmental monitoring is being carried out periodically, and there is no problem in ONAS's environmental monitoring structure.

(4) Implementation status of resettlement and land acquisition

In this project, land was acquired when constructing new sewage treatment plants and laying sewage networks. No resettlement occurred in conjunction with the land acquisition, but more time than initially anticipated was required land acquisition at three sites, Sfax North, Douz, and Hammam Zriba. The reasons for the delay at each site were as follow.

- ✓ Sfax North: It took some time to negotiate with landowner
- ✓ Douz: The landowner had agreed to sell the land prior to project implementation, but due to incomplete documentation on the landowner's part, it became necessary to secure other land.
- ✓ Hammam Zriba: Public land had been secured prior to project implementation, but difficulties arose concerning land acquisition during consultation with the government offices in charge.

2.5. Sustainability (Rating: a)

No major problem has been observed in the capacity of the executing agency and its operation and maintenance system, therefore, sustainability of this project is high.

2.5.1. Executing Agency

2.5.1.1. Operation and maintenance system

Operation and maintenance (O&M) of the sewage treatment plants and related equipment constructed or expanded by this project is under the control of ONAS,[31] the executing agency. O&M is organized as shown on the table below. Of the four operations departments within ONAS, the South Department is in charge of O&M for Sfax, Kebili, and Douz and the North Department is in charge of O&M for Hammam Zriba.

Table-16: Operation and Maintenance System by ONAS (for this Project)

Department	Office in Charge	Facilities and Equipment in charge of O&M (related to this Project)
South Department	Sfax Regional Office (160 staff including 8 engineers)	✓ Sfax Sewage Treatment Plant (North) ✓ Sfax Sewage Treatment Plant (South) ✓ Sewage pipeline network constructed by this project (in Sfax) ✓ Other related facilities and equipment (incl. pumping stations)
	Kebili Regional Office (23 staff including 3 engineers)	✓ Kebili Sewage Treatment Plant ✓ Douz Sewage Treatment Plant ✓ Sewage pipeline network constructed by this project (in Kebili & Douz) ✓ Other related facilities and equipment (incl. pumping stations)
North Department	Zagouan Regional Office (6 staff including 2 engineers)	✓ Hammam Zriba Sewage Treatment Plant ✓ Sewage pipeline network constructed by this project (in Hammam Zriba) ✓ Other related facilities and equipment (incl. pumping stations)

Source: Results of interview with ONAS Sfax Regional Office and Kebili Regional Office

Under the South Department there are seven regional offices. The Sfax Regional Office, the largest of the regional offices, has jurisdiction over O&M of the Sfax Sewage Treatment Plant (North), the Sfax Sewage Treatment Plant (South), and the related sewage network facilities. The Kebili Regional Office, which is also under the South Department, is in charge of O&M of the Kebili Sewage Treatment Plant, the Douz Sewage Treatment Plant, the sewage network in both areas, and related facilities and equipment. Also, there are seven regional offices under the North Department, and the Zaghouan Regional Office is in charge of O&M of the Hammam Zriba Sewage Treatment Plant, its sewage network, and related facilities and equipment.

Amidst a situation that increasing the number of staff members is difficult due to the reform of public companies,[32] ONAS is promoting the introduction of public-private

[31] ONAS was established in 1974. It is a public company affiliated with the Ministry of the Environment, and its main funding sources are (as state below) income from sewage fees and government subsidies. ONAS had five operations departments at the time of the project appraisal, but subsequently the Northeast Operations Department and the Northwest Operations Department were merged to create the North Operations Department, resulting in four operations departments.

[32] The number of ONAS staff members in 2008 (3,456 persons) increased by approximately 300 persons compared to the time of the appraisal (3,003 persons), but there was no large change in the number of staff members during the three years starting from 2006. There are restrictions on the total number of employees at public companies, and so it is difficult to aggressively increase the number of staff members.

partnerships (PPPs) for O&M of sewage treatment facilities as part of its streamlining operations (see details below). Henceforth, ONAS's policy is to actively introduce PPPs for O&M of sewage treatment plants and sewage networks nationwide and to promote reduction of O&M costs.[33] As stated under "Relevance," because "promotion of PPPs" is firmly maintained as an overall goal for the sewage sector in the 11th 5-Year Plan, this series of movements involving introduction of PPPs is, in no small measure, likely to exert a positive impact to no small extent on the financial sustainability of ONAS.

Table-17: Introduction of PPP to Operation and Maintenance (for this Project)

Project Component	PPP Introduced	Private Companies Contracted (Duration of Contract)	Details of PPP Contract
Sfax North	Oct.2008	SOMEDEN Ltd.(Consortium by French and Tunisian private companies) (5 years contract)	✓ O&M activities of Sfax Sewage Treatment Plant (North), related pumping stations and sewage network in Sfax North
Sfax South	Under review	-	-
Kebili & Douz	Jun. 2007	Ameur-Plastics Ltd. (Tunisian private companies) (5 years contract)	✓ O&M activities of Kebili Sewage Treatment Plant and related pumping stations (Sewage network in Kebili is directly operated and maintained by ONAS Kebili Regional Office.) ✓ O&M activities of Douz Sewage Treatment Plant, related pumping stations and sewage network in Douz
Zriba	Under review	-	-

Source: Results of interview with ONAS Sfax Regional Office and Kebili Regional Office

2.5.1.2. Technical capacity

Technical skills of engineers and workers

ONAS had 1,807 technical experts as of the end of 2008. Of these, 272 persons had a baccalauréat＋2 or above[34] (equivalent to a college degree), and 464 persons had a baccalauréat +2 (equivalent to a college-level general education course). There is no problem with the quantity or quality of the engineers and technical staff, and their technological level is also high.

The above-mentioned two private companies which participate in O&M at Sfax North, Kebili and Douz have abundant experience in O&M of sewage treatment plants, and there is no problem in their technical level.

Training programs provided by the contractors of the Project

For the technical experts at ONAS in charge of O&M, the project contractor implemented training concerning O&M technology for sewage treatment plants. Details

[33] There is discussion of introducing the PPP method at 80% to 85% of the sewage treatment plants. (Source: Interview with the head of the Planning Department of ONAS.

[34] Tunisia has adopted the French educational system.

are shown below.

Table-18: O&M Training Provided by the Contractors

Item	Results of Training
No. of Trainees	15 staff in total (Sfax North: 4 engineers, Sfax South: 4 engineers, Kebili: 3 engineers, Douz: 3 engineers, Zriba: 1 engineer)
Implementation Period	For two months during commissioning of each sewage treatment plant
Details of Training Provided	✓ Operation skills of plant facilities ✓ Programming skills and techniques of facility control programs ✓ Manipulation skills of computerized equipment, etc.

Source: Results of interview with ONAS Sfax Regional Office and Kebili Regional Office

The various types of training conducted by the contractor have been implemented without delay as shown above. The trainees gave a high rating to the content of the training.[35] Furthermore, ONAS manages 98 sewage treatment plants in 160 cities nationwide (including the 5 in this project) and a sewage network totaling 13,800 km in length (as of the end of 2007). Many sewage treatment plants similar to those in this project are located in other cities, and so ONAS appears to have accumulated adequate technological expertise and experience related to operation of sewage treatment plants. It is likely that the number of above-mentioned trainees (a total of 15 persons) was determined taking this context into account.

2.5.1.3. Financial status

The profit base is weak due to the low level of sewage fees, but income and expenditure are in equilibrium thanks to government subsidies. Therefore, there is no problem with the financial base.[36]

Revenue and operating profit

As shown on the table on the left below, the sales cost price exceeds the sales, and so deficits are posted annually. Sales have displayed an uptrend for the past three years, but the increase in personnel expenses exceeds the increase in sales (i.e., sales growth during three-year period: 6.6%; personnel expenses growth in same period: 14.9%); thus, the size of the deficit is expanding each year. The increase in depreciation costs is also large. Because new hires of young employees are restrained due to the above-mentioned restriction on the total number of employees, the average age of the employees is rising, and this is likely to be one of the causes of the increase in personnel expenses. Moreover,

[35] Source: Interviews with staff who had received training.
[36] Data for 2008 was not released because auditing of the financial reports was not finished.

because it is politically difficult to hike sewage fees, the deficit is being offset by subsidies from the government.[37]

To sum up the above, although ONAS's profit base is somewhat weak, government subsidies make it possible to maintain equilibrium in income and expenditures.

Table-19: Profit and Loss Statement of ONAS

Unit: million TD

Item	FY2005	FY2006	FY2007
Sales	113.9	120.0	121.4
Revenue from	97.9	102.0	103.8
Sewage Charge			
Cost of Sales	144.4	153.9	160.1
Personnel Expenses	58.2	62.1	66.9
Depreciation	48.4	54.8	55.2
Gross Operating Profit	▲30.5	▲33.9	▲38.7
Profit before Tax	▲36.8	▲41.6	▲46.0

Source: ONAS Audit Reports and JICA internal documents

Table-20: Balance Sheet (B/S) of ONAS

Unit: million TD

Item	FY2005	FY2006	FY2007
Assets			
Current Assets	129	157	163
Quick Assets	81	120	132
Fixed Assets	1,116	1,148	1,204
Total Assets	**1,245**	**1,305**	**1,367**
Liabilities and Equity			
Equity Capital	814	894	927
Current Liabilities	175	113	118
Fixed Liabilities	256	298	322
Total Liabilities and Equity	**1,245**	**1,305**	**1,367**
Recurring Income to Total Assets Ratio (%)	▲3.0	▲3.2	▲3.4
Income to Sales Ratio (%)	▲32.3	▲34.7	▲37.9
Current Ratio (%)	73.7	139.9	138.9
Quick Asset Ratio (%)	46.3	106.2	111.9
Capital Ratio (%)	65.4	68.5	67.8

Source: ONAS Audit Reports and JICA internal documents

Balance Sheet (B/S)

Regarding the Balance Sheet, as shown on the table on the right above, ONAS has a capital adequacy ratio of 68%, current ratio of 139%, and quick assets ratio of 112%. There are no major problems in financial stability or its ability to make short-term payments.

Operation and maintenance expenditure of the Project facilities

The main expenses constituents of O&M costs are (1) electricity expenses, (2) fuel expenses, and (3) personnel expenses. All sewage treatment plants are endeavoring to reduce electricity expenses; however, electricity fees have been rising recently in Tunisia, and so expenditures are in an uptrend.[38]

Meanwhile, through the introduction of PPP mentioned above, a significant decrease in O&M costs is anticipated. At the current time, the effects of such introduction are still unclear because it is in the early stage of introduction, but in the medium to long term, gradual reduction of O&M costs is expected. Incidentally, the total O&M expenditure

[37] The subsidies amount to approximately 30% of annual total income and in FY2007 amounted to 39.5% (source: ONAS Annual Report 2007).

[38] Source: Interviews at the ONAS Sfax Office and the ONAS Kebili Office.

(including O&M expenditures for the sewage treatment plants, sewage network and related facilities) at Kebili and Douz decreased in FY2008 by 80,000 Tunisian dinars year-on-year (from 340,000 dinars to 260,000 dinars). This appears to be the early effects of expense reduction due to the introduction of PPPs in 2007 (see table below for details).

Table-21: Operation and Maintenance Expenditure of the Project (FY2005 to FY2008)

Unit: million TD

Fiscal Year	Sfax North	Sfax South	Kebili	Douz	Zriba
FY2005	1.1	1.0	0.07	0.16	0.06
Fy2006	1.5	1.8	0.08	0.28	0.04
FY2007	1.5	2.3	0.07	0.27	0.08
FY2008[1)]	*0.29*	*0.94*	0.15	0.11	0.05

Source: JICA internal documents and answers to the questionnaire to ONAS

Note 1): O&M expenditure of Sfax (North & South) in FY2008 only includes the expenditure relating to the sewage treatment plant. (O&M expenditure of sewage network is excluded.)

2.5.2. Operation and maintenance status

Generally speaking, there seems to be no problem with the operation and maintenance status, thereby, they can be judged as extremely good.

Basically, there is no problem in the operation or maintenance of the treatment plants. The two previously mentioned private companies are in charge of operation and maintenance, and they are encouraged to carry out efficient operation and maintenance in Sfax North, Kebili, and Douz, by a results-based incentive payment according to the volume of sewage treated. Moreover, they submit monthly reports to the ONAS authorities. (Of the above-mentioned two companies, a field manager of Amuer-Plastics, the company in charge of Kebili and Douz, stated in an interview that there were no particular difficulties in operation and maintenance.)

In Sfax South and Hamman Zriba, the ONAS staff in charge periodically inspects each sewage treatment facility and the sewage network, and remote management is also conducted using surveillance cameras. No particular problems were observed in the onsite survey conducted in April 2009.

No problems have occurred in the procurement of spare parts. Replacement of pumping station equipment is also being carried out in a timely manner.

As stated under “Effectiveness,” the rate of wastewater treated remains at low levels at the Hamman Zriba Sewage Treatment Plant and the Sfax Sewage Treatment Plant (North); however, the main causes are the low percentage of population connected and the low sewage volume per person, and there are no problems caused by operation and maintenance.

3. Conclusion, Lessons Learned and Recommendations

3.1. Conclusion

The components of the project are highly relevant to the related national policies and there seems to be no problem with the operation and maintenance systems. Although some treatment plants are facing slower growth rate of facility utilization (mainly stemming from the external factors such as the declining population growth rate), a certain number of positive impacts has been developed through the implementation of the project. In light of the above, this project is evaluated to be satisfactory.

3.2. Lesson Learned

Regarding the main cause of the large delay in the project period, which was "the large delay in the selection of the detailed design (D/D) consultant due to the increase in treatment capacity of the Sfax Sewage Treatment Plant (North)," it was decided at the time of the appraisal to procure the above detailed design consultant using World Bank funds. So, the tasks of procurement of the consultant and the supervision of the work were not included in the project in advance. Particularly in cases where critical pass activities which decisively impact the project period (such as detailed design) are funded by other donors (i.e., the World Bank in this project) and not included in the project's tasks, it is desirable to have closer communication and better all-around coordination with the said donor (to check the progress of tasks outside the project and to accelerate that progress).

Moreover, in southern Tunisia where Kebili and Douz are located, landownership is historically not clear, and it has been pointed out that, for that reason, land acquisition invariably involves time and money. In view of this situation, when organizing a project that includes project sites in southern Tunisia, it is desirable to endeavor to understand the social and cultural background of the region and to anticipate corresponding risks in advance at the stage of project planning, even if agreement has been reached on land acquisition prior to project implementation. (Furthermore, it appears that the Tunisian government is currently following a strict rule that "projects cannot be started unless land acquisition is complete" when implementing public projects such as sewage installation. Thus, the likelihood of the above situation occurring again is small.)

3.3. Recommendations

(For executing agency)

Because the harmful effect (e.g., lack of increase in the rate of wastewater treated and foul odor due to lack of sewage connections, etc.), resulting from the low rate of

population connection to sewage system, has been pointed out, it is hoped that ONAS, the executing agency, will redouble its efforts to boost the percentage connected. For example, it would be desirable to have detailed studies as soon as possible on the further expansion of connection fee discount schemes (currently there is a scheme for charging low-income earners half of the usual connection fee of 260 Tunisian dinars) and on measures for further developing the sewage network.

Comparison of Original and Actual Scope

Item	Plan	Actual
A) Output		
1. Sfax		
1.1 Construction of new plant (North)	Design capacity: 10,000m^3/day	17,900m^3/day
1.2 Expansion of existing plant (South) Design capacity :24,000m^3/day (before rehabilitation)	Design capacity: Doubling the existing plant	Mostly as planned (49,500m^3/day)
1.3 Construction of sewage pipelines	156.5km in total	289km in total
1.4 Construction of new pumping stations	11 stations	9 stations
2. Kebili		
2.1 Construction of new plant	Design capacity: 3,130m^3/day	3,110m^3/day
2.2 Construction of sewage pipelines	29.6km in total	36km in total
2.3 Construction of new pumping stations	2 stations	3 stations
3. Douz		
3.1 Construction of new plant	Design capacity: 4,700m^3/day	As planned
3.2 Construction of sewage pipelines	36.7km in total	62km in total (10km for connecting Golaa network and Douz new plant as an additional output)
3.3 Construction of new pumping stations	2 stations	As planned
4. Zriba		
4.1 Construction of new plant	Design capacity: 2,000m^3/day	1,800m^3/day
4.2 Construction of sewage pipelines	6.6km in total	Mostly as planned (7.0km)
4.3 Rehabilitation of sewage pipelines	6.5km in total	Mostly as planned (7.0km)
4.4 Construction of pumping stations	4 stations	As planned
5. Operation and maintenance equipment	51 items in total High-pressure washer trucks (15 vehicles), Vehicles with investigative cameras (1 vehicle), Business vehicle (24 vehicles), Other equipment (11 items)	68 items in total High-pressure washer trucks (17 vehicles), Vehicles with investigative cameras (3 vehicles), Business vehicle (44 vehicles), Vaccuum machine (4)
6. Consulting services (C/S)	30 M/M	34.57 M/M
B) Project Period	January 1996 – December 2000 (60 months)	January 1996 – October 2006 (130 months)
C) Project Cost		
Foreign currency	2,126 million yen	348 million yen
Local currency	6,393 million yen (58,114 thousand TD)	8,088millon yen (92,570 thousand TD)
Total	8,518 million yen	8,436 million yen
Japanese ODA loan portion	6,389 million yen	6,386 million yen
Exchange rate	1 Tunisia Dinar＝110 yen (as of April 1996)	1 Tunisia Dinar＝87.32 yen (Average for 1998 - 2006)

Appendix – Operation and Effect Indicators

Operation and Effect Indicators (1/2): Sfax North, Sfax South and Grand Sfax

Indicators (Unit)	Sfax North			Sfax South			Grand Sfax		
	Baseline (1996)	Actual (2007)	Target (2011)	Baseline(1996)	Actual (2007)	Target (2011)	Baseline (1996)	Actual (2007)	Target (2011)
Operation Indicators									
Total Population (people)	Unknown	90,300[2)]	96,200[2)]	Unknown	407,950[2)]	434,530[2)]	430,000[8)]	498,250[2)]	53,0730[2)]
Population Treated (people)	Unknown	38,829[2)]	62,530[2)]	Unknown	299,843[2)]	395,420[2)]	193,500[3)]	338,672[2)]	457,950[2)]
Wastewater Treated (㎥/day)	-	5,560[2)]	17,900[4)]	15,111[9)]	28,186[2)]	49,500[4)]	15,111[9)]	33,746[2)]	67,400[4)]
Rate of Facility Utilization (%)	-	31[5)]	100[5)]	63[5)10)]	57[5)10)]	100[5)]	63[5)10)]	50[5)11)]	100[5)]
BOD (Mg/L)	400[12)]	544, 29[6)]	No Target	Unknown	574, 40[6)]	No Target	-	-	-
TSS (MES) (Mg/L)	400[12)]	622, 27[6)]	No Target	Unknown	609, 45[6)]	No Target	-	-	-
Rate of Sludge Recycled (%)	-	0[8)]	50	Unknown	0[8)]	50	Unknown	0[8)]	Unknown
Effect Indicators									
% of Population Served (%)	30[8)]	43.0[2)]	65.0[2)]	Unknown	73.5[2)]	91.0[2)]	45[7)]	68.0[2)]	86.3[2)]
Improvement of Water Quality at treated water discharge			No Target	Unknown		No Target	-	-	-
BOD (Mg/L)	-	29[4)]			40[4)]				
COD (Mg/L)	-	Unknown			Unknown				

Note 1): "－" means "not applicable", because BOD/TSS data of Grand Sfax does not exist and there was no sewage treatment plant in Sfax North in 1996.
Note 2): Source: JICA internal documents
Note 3): Percentage of population served in 1990, 45%, (source: JICA internal documents) multiplied by the total population in 1996, 430,000 people
Note 4): Source: JICA internal documents
Note 5): The amount of wastewater treated (daily average) divided by the treatment capacity of the sewage treatment plant (Rate of facility utilization＝ The amount of wastewater treated (daily average) / Treatment capacity of the plant)
Note 6): Influent quality (left) and effluent quality (right) (Source: JICA internal documents)
Note 7): Baseline data in 1990 (Source: JICA internal documents)
Note 8): Source: Answers to the questionnaire to ONAS
Note 9): Actual data in 1997 (Source: JICA internal documents, forecasted by ONAS)
Note 10): Facility utilization rate in 1996 is calculated for the treatment capacity of 24,000m^3/day, while that in 2007 is for the treatment capacity of 49,500m^3/day.
Note 11): Facility utilization rate in 2007 is calculated for 67,400m^3/day (＝17,900＋49,500).
Note 12): Influent quality in 1997 (forecasted data, Source: JICA internal documents). No data for Sfax South
Note 13): "No Target" means "There was/is no clear target at the time of project appraisal and as of now". (answered by ONAS)

Operation and Effect Indicators (2/2): Kebili, Douz and Hammam Zriba

Indicators (Unit)	Kebili			Douz[12)]			Hammam Zriba		
	Baseline (1996)	Actual (2007)	Target (2011)	Baseline(1 996)	Actual (2007)	Target (2011)	Baseline (1996)	Actual (2007)	Target (2011)
Operation Indicators									
Total Population (people)	17,166[2)]	19,410[3)]	20,490[3)]	25,204[2)]	35,520[3)]	37,510[3)]	7,627[2)]	9,396[3)]	9,950[3)]
Population Treated (people)	7,725[4)]	17,663[3)]	18,850[3)]	0[4)]	23,254[3)]	31,800[3)]	6,102[4)]	8,964[3)]	9,530[3)]
Wastewater Treated (㎥/day)	-	2,073[3)]	Unknown	-	1,866[5)]	Unknown	-	344[3)]	Unknown
Rate of Facility Utilization (%)	-	67[6)]	Unknown	-	40[6)]	Unknown	-	19[6)]	Unknown
BOD (Mg/L)	512[9)]	309, 21[7)]	No Target	509[9)]	168, 17[7)]	No Target	Unknown	424, 33[7)]	No Target
TSS (MES) (Mg/L)	486[9)]	498, 17[8)]	No Target	Unknown	338, 23[8)]	No Target	Unknown	348, 44[8)]	No Target
Rate of Sludge Recycled (%)	-	0[8)]	Unknown	-	0[8)]	Unknown	-	0[8)]	Unknown
Effect Indicators									
% of Population Served (%)	45[10)]	91.0[3)]	92.0[3)]	Approx.0%[10)]	65.5[3)]	84.8[3)]	80[10)]	95.4[3)]	95.8[3)]
Improvement of Water Quality at treated water discharge			No Target			No Target			No Target
BOD (Mg/L)	-	21[5)]		-	17[5)]		-	33[5)]	
COD (Mg/L)	-	Unknown		-	Unknown		-	Unknown	

Note 1): "－" means "not applicable", because there were no sewage treatment plants in 1996.
Note 2): Source: Answers to the questionnaire to ONAS
Note 3): Source: JICA internal documents
Note 4): Percentage of population served in 1994 (Source: JICA internal documents) multiplied by the total population in 1996
Note 5): Source: JICA internal documents
Note 6): The amount of wastewater treated (daily average) divided by the treatment capacity of the sewage treatment plant (Rate of facility utilization＝ The amount of wastewater treated (daily average) / Treatment capacity of the plant)

Note 7): Influent quality (left) and effluent quality (right) (Source: JICA internal documents)
Note 8): Source: Answers to the questionnaire to ONAS
Note 9): Influent quality in 1996 (forecasted data, Source: JICA internal documents)
Note 10): Baseline data in 1994 (Source: JICA internal documents)
Note 11): "No Target" means "There was/is no clear target at the time of project appraisal and as of now". (answered by ONAS)
Note 12): Baseline and actual data regarding total population, population treated and percentage of population served shown in this column consider the connection between Douz Sewage Treatment Plant and sewage network in Golaa.