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 25,900$m^3$/day (approximately 0.3$m^3$/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 $m^3$<br>• Pumping station: the capacity of 12 $m^3$/sec.（4 $m^3$/sec.×3 units）<br>• 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<br>• Equipment: PC, software, electric generator, etc.<br>• Small wireless communications facilities to allow remote control: 54 sites[6] | =>Almost as planned<br>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<br>• 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.<br>(* 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

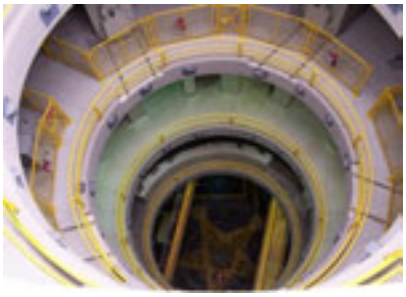


Figure 2: Inside View of Pumping Station (pumping units are set at the bottom)

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).

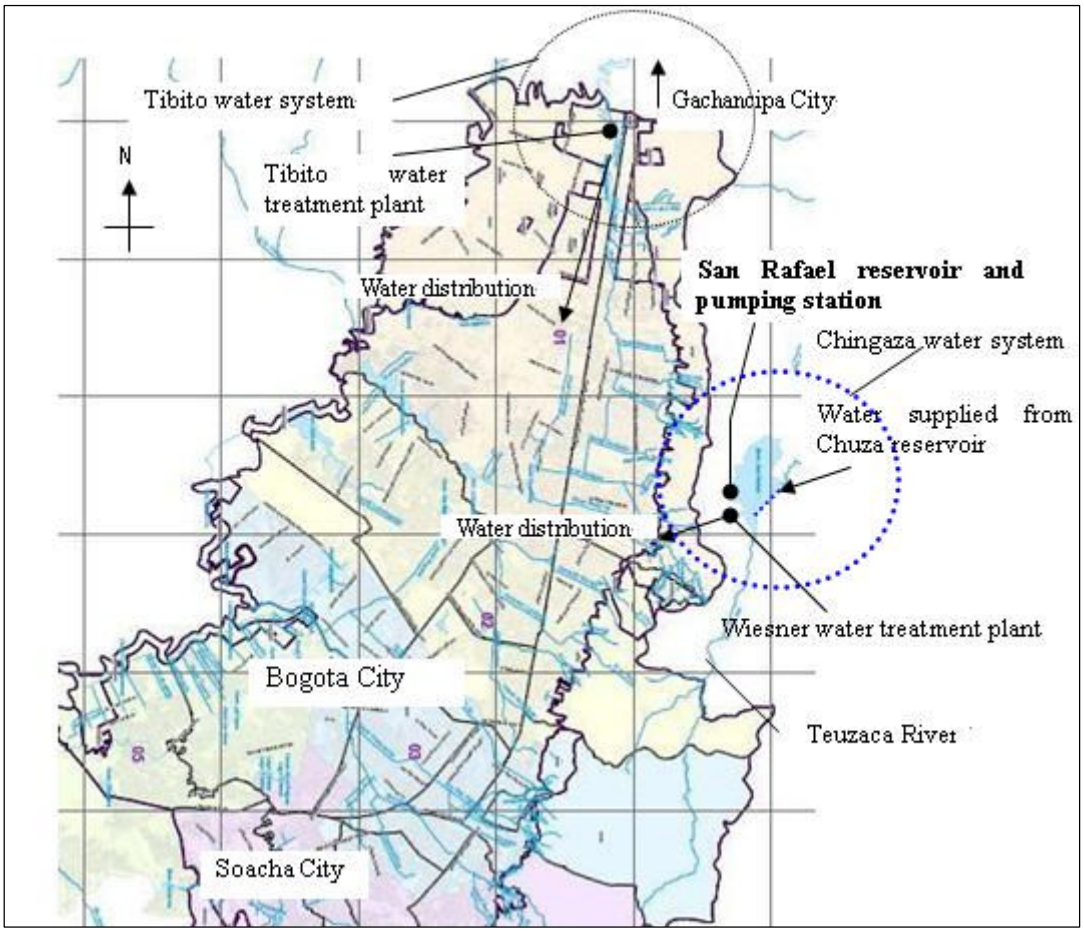



Figure 7: Project Site[9]

[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<br>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 |

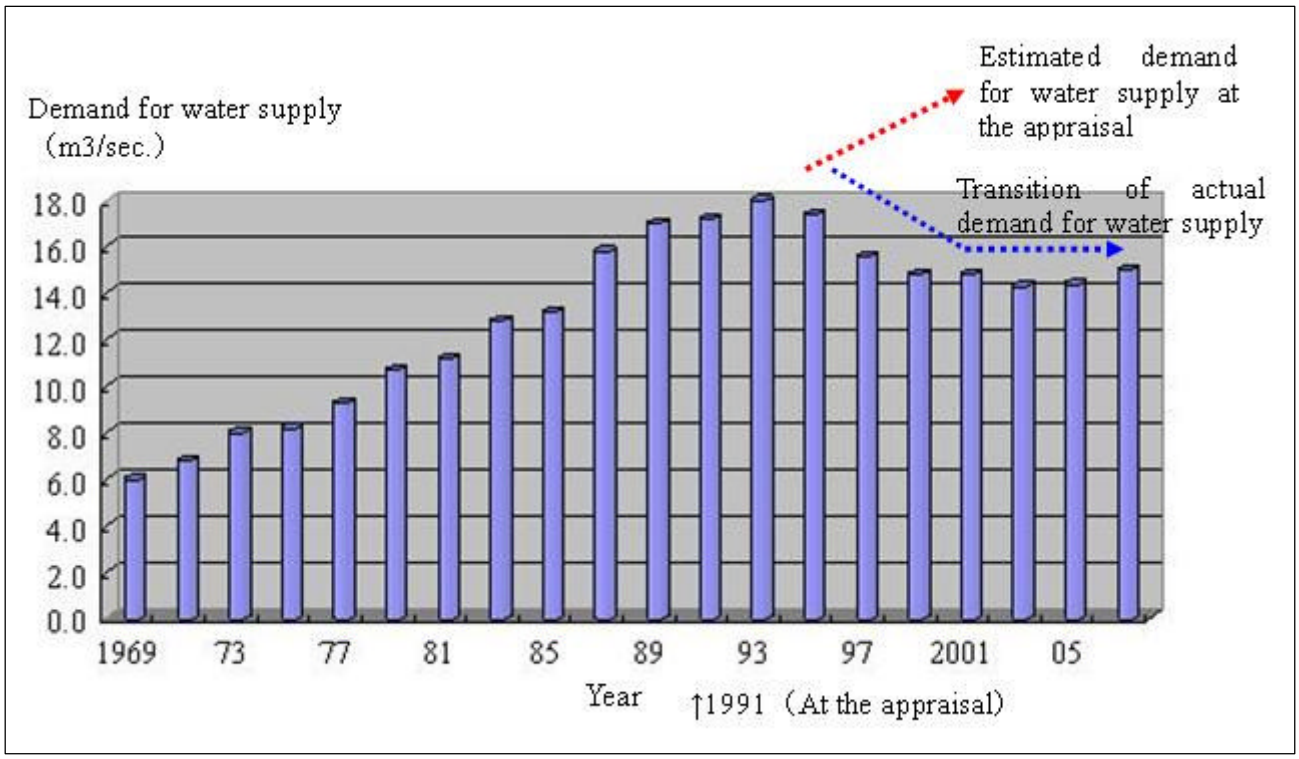
| | | | |
|---|---|---|---|
| | 2008 | 1,299 | 802 |

*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 14-15$m^3$/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.

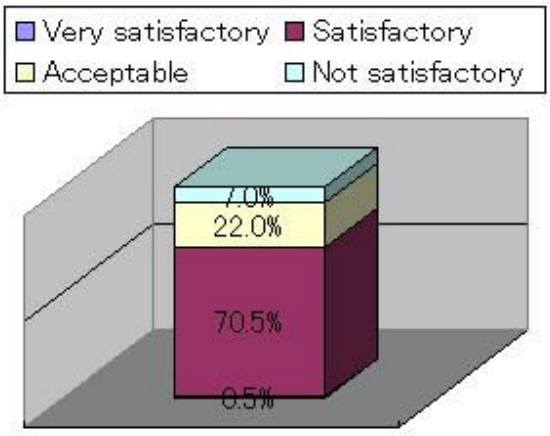



Figure 10: Water Pressure

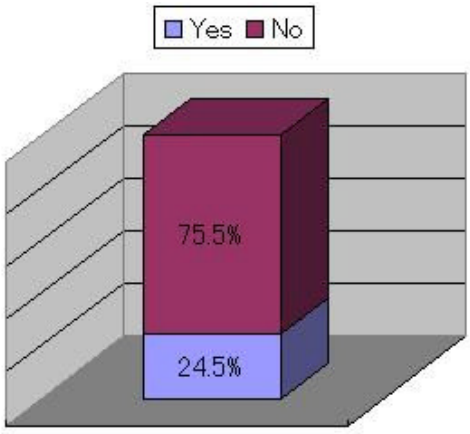



Figure 11: Presence of Water Impurity

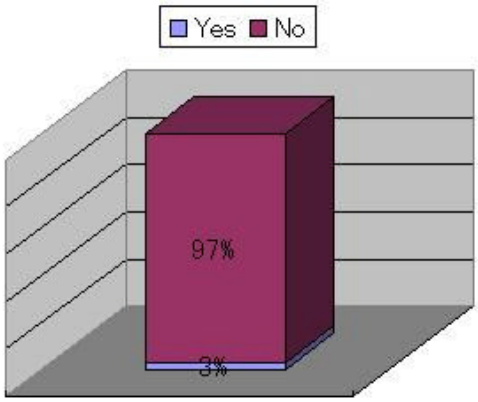



Figure 12: Presence of Water Stench

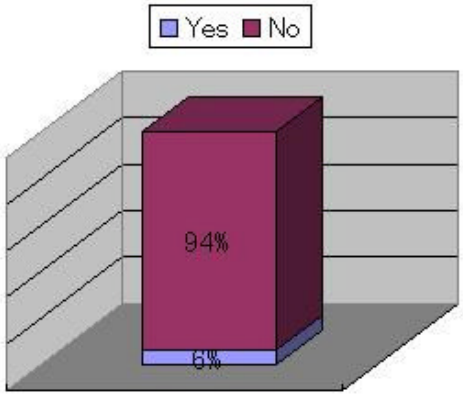



Figure 13: Presence of Diarrhea-Related Disease in the Last 15 Days

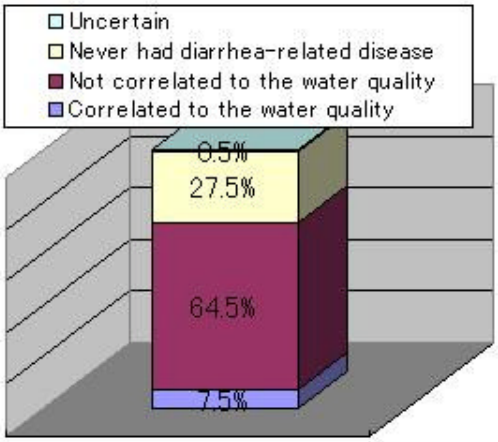



Figure 14: Correlation Between Diarrhea-Related Disease and Water Quality

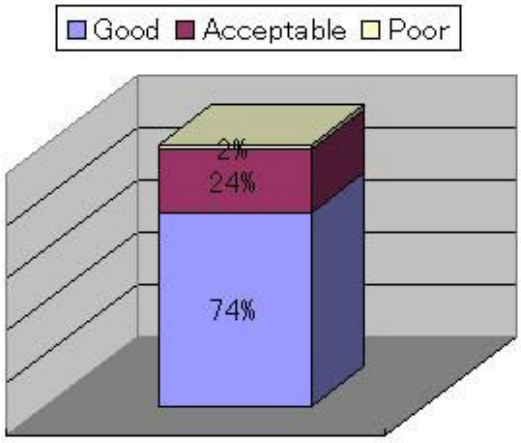



Figure 15: Service of the Executing Agency

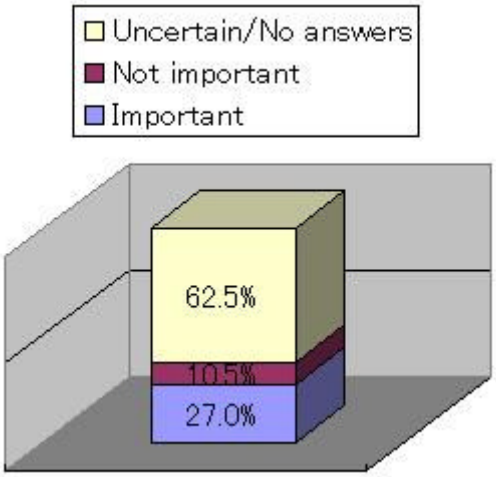



Figure 16: Importance of San Rafael Reservoir[17]

[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.

.

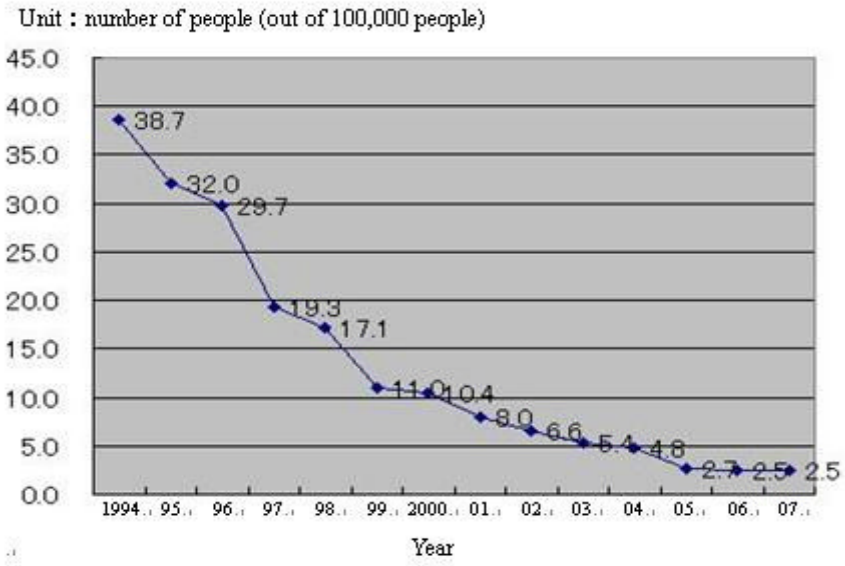



Figure 17: Transition of the Mortality Rate of Infants
Under Five Years Old due to Diarrhea Related Disease in Bogota City

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