Ecuador

Ex-Post Evaluation of Japanese Grant Aid Project
The Project for Improving Water Supply Systems in the Cities of Huaquillas and Arenillas

External Evaluator: Tsuyoshi Ito, IC Net Limited

0. Summary

This project was implemented to realize 24-hour water supply in Arrenillas and Huaquillas, which are left behind for their socio-economic development due to the influence of the conflict over the border between Peru and Ecuador. This project is consistent with the priority areas in Ecuador's national development policies and Japan's aid policy, and is also very consistent with development needs in the target region. Accordingly, the relevance of this project's implementation is high. The project's costs and duration are both in line with the plan, indicating that efficiency is also high. The targets for clean and safe water production capacity have been achieved, but the goal to provide users with benefits such as 24-hour water supply was not achieved. Moreover, the anticipated economic and public health impacts did not materialize. For these reasons, the project's effectiveness is fair. There are major problems with organizational sustainability, such as lack of decision on the organizational approach for the local water utilities administrations in the cities of both Huaquillas and Arenillas, the project's implementing organizations. There are also financial issues. Thus the sustainability of the project's effects is deemed to be low.

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

1. Project Description

Project Locations

Water treatment plant built by the project

1.1 Background

In its national development plan running from 2001 to 2005, the Ecuadorian government aspired to meet water demand and prevent water-borne diseases by building and upgrading water supply facilities.

The cities of Arenillas and Huaquillas in El Oro province, this project's target region, are located near the border with Peru. Development in this region has been delayed due to border disputes between these two countries over the past 50 years. In order to solve problems caused by obsolete water supply systems and to prepare for the future increase in water demands in the cities, both cities devised a water supply plan for an inexpensive and reliable waterworks system whereby water would be drawn from Tahuin Dam, a multi-purpose dam in Arenillas, and then supplied and distributed using a gravity fed system. This plan was devised as part of a study

carried out with support from a Peru-Ecuador Binational Peace and Development Fund[1]. The design of the water supply system adopted an idea that the two cities share a same water source from Tahuin Dam. This idea was the only possibility because Arenillas River, which holds Tahuin Dam, was the only water source in the area.

However, due to shortage of available fund, the Ecuadorian government requested grant aid cooperation from the Japanese government in February 2002. In response, the Japanese government sent a preliminary study team to Ecuador in May 2004, followed by the first basic design study team from November 2004 to March 2005 and the second basic design study team from June to November 2005. In addition to considering the specific location for the water treatment plant and the structure and construction site for the distribution reservoir, a basic design proposal was prepared. Based on these study results, agreements on this project to be carried out with grant aid cooperation were concluded in January 2006.

1.2 Project Outline

The objective of this project is to ensure a 24-hour water supply in the two urban areas in Arenillas and Huaquillas by constructing a regional water treatment plant and providing the intake pumps, water pipes to distribute the water to the city of Huaquillas, and the water pipes within Huaquillas.

The project's implementing agency is the local water utilities administration in Arenillas and Huaqillas, which were set up by the two cities (Empresa Municipal Regional de Agua Potable de Arenillas y Huaquillas; hereinafter "EMRAPAH").

Grant Limit/Actual Grant Amount		2,058 million yen/2,043 million yen
Exchange of Notes Date		Detail Design: January 2006/Construction: May 2006
Implementing Agency		Local water utilities administrations in the cities of Arenillas and Huaqillas (EMRAPAH)
Project Completion Date		February 2009
Project Contractors	Main work	Taisei Corporation
	Consultants	Joint venture of Kyowa Engineering Consultants Co., Ltd., and Nihon Suido Consultants Co., Ltd.
Basic Design		First: November 2004 – March 2005 Second: June – December 2005
Related Projects		None

2. Outline of the Evaluation Study

2.1 External Evaluator

Tsuyoshi Ito, IC Net Limited

2.2 Duration of Evaluation Study

Duration of the Study: September 2011 – November 2012

Duration of the Field Study: November 22 – December 9, 2011, April 28 – May 11, 2012

[1] The fund was established with support from the United States in 2000 as a result of the 1998 peace agreement with Peru.

2.3 Constraints during the Evaluation Study

None.

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

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance with the Development Plan of Ecuador

In Ecuador's national development plan (2001-2005), which was in effect when this project was being planned, building and upgrading water supply facilities was the most important issue, and improving public health conditions in small-scale self-governing municipalities was to be pursued as a priority. The cities of Arenillas and Huaquillas, the project's target regions, were designated as priority regions for this infrastructure development.

Access to safe water is identified as a human right in the current constitution that took effect in 2008.

The latest national development plan (2009-2013), in effect during this ex-post evaluation, identifies water supply as one of the priority issues. Developing water supply infrastructure has been a national priority from the time this project was planned through this evaluation.

Accordingly, this project is consistent with policies in Ecuador.

3.1.2 Relevance with the Development Needs of Ecuador

The two target cities are located near Ecuador's border with Peru, a region in which the impact of the border disputes between the two countries has led to delays in establishing basic economic and social infrastructure compared to other regions. The Peru-Ecuador Binational Fund for Peace and Development was established in 2000 after the 1998 peace accord between the two countries. Past projects financed by the fund include three waterworks-related projects, two roads projects, two education projects and one livestock project, showing that the needs in the waterworks area were high. However, the proposed budget for the water supply project by this plan was too large for the Ecuadorian government and for most of the potential donors to consider its materialization.

Looking at the condition of the waterworks supply systems in the two cities at that time, it is noted that restrictions were placed on the water supply in Huaquillas due to lack of development and deterioration of water pipes. Underground water was the only water source, and it was directly pumped from wells, resulting in problems such as excessively high costs for pump fuel and the inability to obtain water when the pump broke down. As a result, many households had their own water storage tanks and pumps, and there were concerns that this siphoning off of water using household pumps would lead to contamination with dirty water.

Similarly, Arenillas also restricted water supply as a result of the deterioration of the water treatment plant and problems with distribution pipes. Moreover, some regions were not covered by the water supply network, and only received water via a water wagon. Since the capacity of the water treatment plant was inadequate, highly turbid water was supplied without being treated during the rainy season.

The populations of the two cities were continuously increasing at the time of this evaluation, which implies the needs for stable water supply to the urban areas in the cities remained high. Given these conditions, the development needs in the water supply sector in the two target cities

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[3] ③:High, ②:Fair, ①:Low

were high.

3.1.3 Relevance with Japan's ODA Policy

Japan's basic aid policy for Ecuador in fiscal 2005 was "to provide aid in the three priority sectors of poverty countermeasures, environmental conservation and disaster prevention, primarily through grant aid cooperation and technical cooperation." In addition, now that Peru and Ecuador had achieved peace, grant cooperation projects and technical cooperation projects carried out with the aim of providing development support in the border region between Peru and Ecuador were given priority. The "waterworks and sewage" sector was one of the individual priority sectors, included as part of "development of basic infrastructure in "poverty countermeasures." This aid policy was kept in place in fiscal 2006, when this project was implemented.

This project is consistent with Japan's aid policy at that point, given that the project was in the waterworks and sewage sector, one of the priority areas for aid, and the project contributed to the development of the region along the border with Peru.

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

3.2 Effectiveness[4] (Rating: ②)

3.2.1 Quantitative Effects

3.2.1.1 Operation Indicator

The regional water treatment plant produces 100 liters/second of water as planned.

3.2.1.2 Effect Indicator

The amount of water supplied per person, the water supply duration, and the residual chlorine concentration were set as the indicators showing the effect of this project. Information on users' satisfaction from a beneficiary survey carried out in this evaluation study was added to these indicators for analysis.

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

Table 1: Achievement of Targets in Arenillas

Indicator	Baseline (2004)	Target (2008)	2010	2011
Population (people)	15,183	16,759 (2008) 17,608 (2010)	21,326 (2010 census)	
No. of registered users[5] (cases)	2,831	-	3,926	4,047
Water supply	Water source pumps supply 4,780 m^3/day (about 55 liters/sec.)	Water supply capacity of the water treatment facility shared by both cities is 28 liters/sec (about 2,419 m^3/day) of the 100 liters/sec (8,640 m^3/day)	30 liters/sec	30 liters/sec
Amount of water supplied per person	133 liters/day	150 liters/day	No data	No data
Water supply duration	Average 46 hours per week	24 hours/day	21.5 hours/day	21.5 hours/day 24 hours of water supply in 16 of 35 zones
Residual chlorine concentration	0.12mg/liters in central urban areas only	More than 0.1mg/liters throughout the project target area	Undercuts this level in some areas	Undercuts this level in some areas

Source: Materials provided by EMRAPAH, information from the questionnaire and interviews to EMRAPAH

[5] Officially registered users connected to water distribution pipes. Generally households.

Table 2: Achievement of Targets in Huaquillas

Indicator	Baseline (2004)	Target (2008)	2010	2011
Population (people)	44,665	51,056 (2008) 54,587 (2010)	48,285 (2010 census)	No data
No. of registered users (cases)	7,683	-	12,046	12,223
Water supply	Total production volume of water source (well) is 6,680 m^3/day (about 77 liters/sec.)	72 liters/sec (about 6,220 m3/day) of 100 liters/sec (8,640 m3/day)	70 liters/sec	70 liters/sec
		Amount of well water supplied	60 liters/sec	60 liters/sec
Amount of water supplied per person	About 130 liters/day	150 liters/person/day	No data	No data
Water supply duration	Average 56 hours per week	Tap water is supplied to households 24 hours/day	Average of about 20 hours/day of service, with 24 hours/day for 60% of regions, 12 hours/day in 30% of regions, and less than 8 hours/day in 10% of regions	Average of about 20 hours/day of service, with 24 hours/day for 60% of regions, 12 hours/day in 30% of regions, and less than 8 hours/day in 10% of regions
Residual chlorine concentration	Not detected in almost all neighborhoods	Less than 0.1mg/liters region-wide	Undercuts this level in some areas	Undercuts this level in some areas

Source: Materials provided by EMRAPAH, information from the questionnaire and interviews to EMRAPAH

① Amount of water supplied per person

This data could not be determined because EMRAPAH was not able to collect it. The main reasons that this data could not be collected were that little progress has been made in installing water gauges in homes and water gauges are not read even in homes where water gauges have been installed. Data on this indicator was not even collected during the basic design study of the project, and the study applied a figure of Machala city, the capital of El Oro state as the target value of the project plan. The basic design study did not propose any method to measure achievement of the project with regard to this indicator, and this

evaluation decided not to use this indicator as a means of performance measurement of the project.

② Water supply duration

In Huaquillas, 60% of the target area receives water for 24 hours, 30% receives for 12 hours, and 10% for less than 8 hours. Overall achievement rate can be calculated as 78.3% (60x1.0+30x0.5+10x0.33). In Arenillas, 16 out of 35 zones receive water for 24 hours. EMRAPAH does not have zone wise data of water supply hours, but they explained average water supply hour in the other 19 zones is about 12 hours. Based on this information, overall achievement rate is 72.9% (16/35x100x1.0+19/35x100x0.5). Calculation of a weighted average of the achievement rates of two cities using the water division rate of 7:3 between Huaquillas and Arenillas gives a total achievement rate of 76.7%.The areas, where water supply duration is inadequate are always found in certain areas in both cities. EMRAPAH contends that this is attributable primarily to inadequate water pressure. Elevation is somewhat higher than the water treatment plant in some parts of the cities, so the water pressure of water from the treatment plant is insufficient. Moreover, in regions receiving water from the Loma Quito water treatment plant[6] in Arenillas, water pressure declines when the water supply from the Loma Quito plant is backed up, preventing water from being supplied.

Although detailed information could not be obtained, in Arenillas, the urban region outside the center of the city initially envisaged in the project is developing, and the rising population in this region could be destroying the overall water supply/demand balance, which may be another cause of the low water pressure. Indeed, the 2010 census results showed that the population of Arenillas was 21,326 in 2010, about 1.2 times the 17,608 projected in the basic design survey.

In addition, power outages are having an impact. These power outages are not very frequent, occurring a few times a week, and not all of the power outages are significant. However, according to EMRAPAH, it takes time to restore the water treatment plant and intake site pumps once there is a major power outage, and sometimes the water treatment plant is out of operation for two to three days. The unstable power supply seems to affect the potential to realize stable water supply.

The connection rate, rate of connected households in respective cities, increased from about 60% to 95% in Arenillas with the city's laying of distribution pipes in 16 channels in 2008, and stood at 100% in Huaquillas.

③ Water quality

The residual chlorine concentration of water sent from the regional water treatment plant is measured on a daily basis, and is kept above 0.1 mg/ℓ. Water quality tests are carried out every week for the end-user as well at four sites, with the testing site changed by the week. This testing has showed that the concentration falls below 0.1 mg/ℓ in some places, but overall the necessary chlorine concentration is maintained region-wide.

Daily testing and sample tests at four end-user sites by EMRAPAH indicate that there are no problems with aspects of water quality besides residual chlorine concentration.

[6] Due to serious deterioration, water supply capacity of Loma Quito treatment plant has been decreased significantly and quality of water is also in worrying situation.

Nevertheless, although there is no official data, in some areas of Arenillas at high elevation, water from the water intake is sent directly without any treatment due to the low water pressure of water from the treatment plant. In these regions, there is a possibility that the water quality is not appropriate.

3.2.2 Qualitative Effects

During this evaluation study, a beneficiary survey was conducted with 106 samples, 42 in Arenillas and 64 in Huaquills. Samples were selected evenly and randomly from regional blocks of two cities.

3.2.2.1 Beneficiaries' Satisfaction with Water Quality

According to the beneficiary survey carried out as part of this evaluation study, 28% of the respondents in Huaquillas and 19% of them in Arenillas sensed a smell other than chlorine. More than 70% of the people in Huaquillas attesting that the water smelled described it as a putrid odor. However, as a result of this project, the well water and the water from the treatment plant intermingle at the juncture of the water service pipes. Thus it is unlikely that the odor of the well water would still be present when it arrived at the end-user. The problem likely lies with the water service pipes and/or the individual households' water storage tanks.

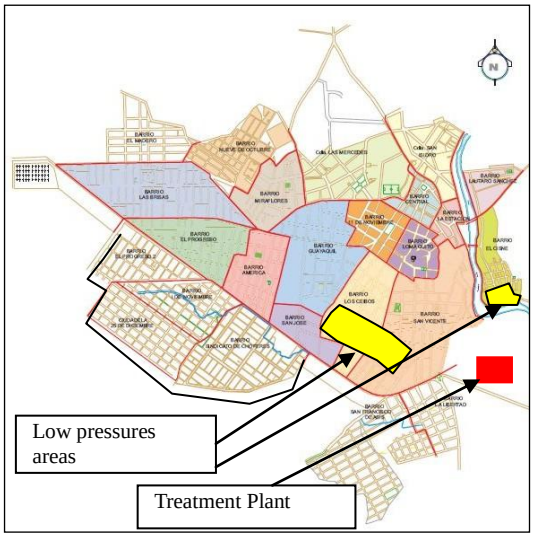
Almost no respondents in the beneficiary survey said that they drink the tap water as is. Half of the respondents boil the water and the other half buy drinking water, indicating that the credibility of tap water as drinking water among the users is low.

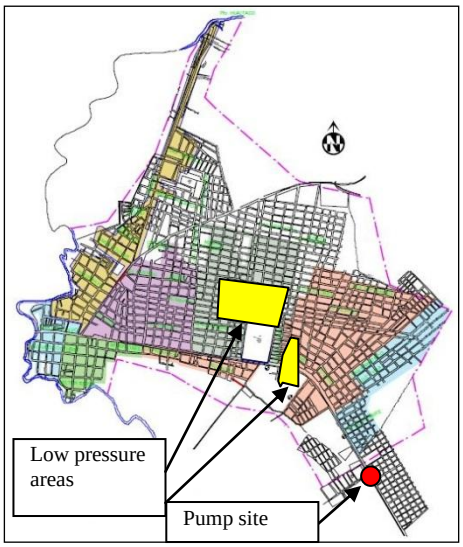
However, as noted above, water quality tests indicated no particular problems. Thus the dissatisfaction expressed by the beneficiaries is likely an issue of preferences such as taste, rather than a safety problem.

3.2.2.2 Beneficiaries' Satisfaction with Water Volume, Water Pressure and Service Overall

According to the results of the same beneficiary survey, 32% of the respondents in Huaquillas and 19% in Arenillas stated that water pressure was "low" or "absent." When the EMRAPAH offices used maps to confirm this, it was found that there were areas in which water pressure did not rise in some areas of the cities characterized by high elevation.

Selection of the location of the treatment plant was one of the priority issues of the basic design study of the project, and the selection was made considering availability of land and suitability for the water delivery system by the gravity.





Source: Materials provided by EMRAPAH and information obtained in interviews to EMRAPAH

Fig. 1: Low-pressure regions in Arenillas

Fig. 2: Low-pressure regions in Huaquillas

In this survey, 63% of the respondents in Huaquillas and 52% in Arenillas said that they were satisfied with current water supply services overall (total of "very satisfied" and "satisfied" responses). This is just over half of all the respondents. This project made contribution to improve water supply hours, although it did not reach the original target, and also contributed to maintain the water quality properly. However, low credibility of water quality and dissatisfaction to the water supply service of the users are still persistent. These may be caused partly by the low quality of the water from Loma Quito and instability of water supply from the wells in Huaquillas. At the same time, shortfall of public relation activities by EMRAPAH to send correct information to its users to make them understand the improvement in the water supply service seems to be another cause.

As a result of the above, although the effect has been produced as in the initial plan of water production capacity of the regional treatment plant and proper water quality, the targets for water supply duration have not been reached.

3.3 Impact

3.3.1 Intended Impacts

3.3.1.1 Economic Effect of Decreasing Pump Use

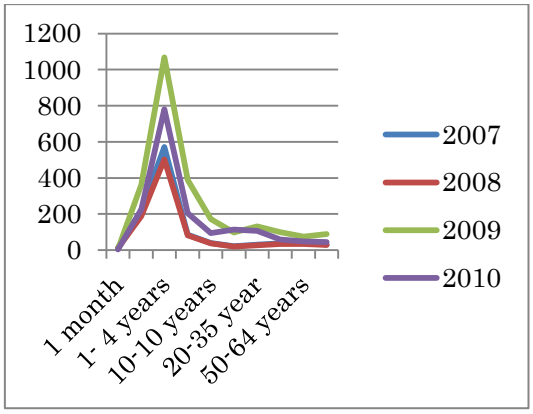
According to the beneficiary survey conducted in this evaluation study, the usage rate for pumps by household in Huaquillas stands at about 25%, almost unchanged from 23% in 2008. Most of the respondents who used a pump in 2008 still use a pump in 2011, and the usage duration was also about the same in 2008 and 2011. Given this, it is fair to surmise that reliance on the pumps is about the same as it was before the project. It was not possible to calculate the electricity costs for the parts only used by the pumps because many are electrical pumps. However, it is safe to say that there was no significant change in the cost of pump use[7].

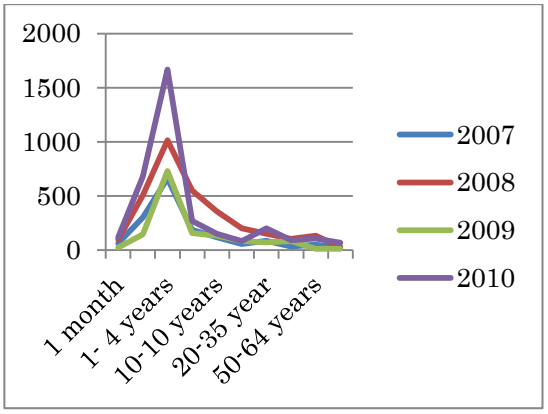
[7] The basic study report of this project mentions that before the project, most of the area was supplied water with insufficient water pressure and most of the households were using suction pumps, although the report does not show how the data was collected and no exact figure of rate of pump use among the target households was specified. Due to this situation, this evaluation conducted analysis based on the data on pump use before and after the project which

3.3.1.2 Impact on Improving Health

Water-borne illness cases by age by year between 2007 and 2012 obtained from two municipal hospitals of the cities are shown in the graphs below. Since the completion of the project was February 2009, data of 2007 and 2008 can be regarded as pre-project data, and those of 2009 and 2010 as post-project data. In all years, 1 to 4 year old group shows highest number of cases and tendency of number of cases by age among the sample years is basically the same.

However, it does not appear that the prevalence rate of water-borne diseases in the target regions improved after the project[8].





Source: Data from the municipal hospitals in Arenillas and Huaquillas

Fig. 3: Water-borne illnesses in Arenillas

Fig. 4: Water-borne illnesses in Huaquillas

3.3.2 Other Impacts

3.3.2.1 Impacts on the Natural Environment

The concentrated sludge treated in the sludge tank and sludge concentration tank are dried and disposed of on a designated site in the treatment plant premises with a proper manner. Although data on exact amount of disposal was not found, based on the on-site observation, during this evaluation, the volume was not very large, and there would be no impact on the environment.

3.3.2.2 Land Acquisition and Resettlement

Land of about 8,000 square meter was acquired for the water treatment plant from a private owner when the project was implemented, but there were no problems because appropriate legal procedures were followed, and no relocation took place.

As such, the project's goal has been achieved as planned in terms of water production and water quality, and the goal of providing 24-hour water supply has not been fully achieved with about 77% of achievement rate. Meanwhile, the anticipated contribution to economic gain by reduction of private pump use and hygienic impacts were not confirmed. Accordingly, this project has somewhat achieved its objectives, therefore its effectiveness and impact are fair.

collected through the beneficiary survey conducted during this evaluation.

[8] There can be other causes of water-borne illness than the contaminated tap water, however, this evaluation study could not include detail analysis to identify exact cause(s) of the illness.

3.4 Efficiency (Rating: ③)

3.4.1 Project Outputs

Table 3 shows the outputs provided as part of this project's grant aid cooperation (planned and actual), and Table 4 shows the outputs provided by Ecuador (planned and actual).

The following techniques were adopted to reduce operating costs for the aforementioned facilities and equipment.

- Instead of using dam water as the water source, as proposed in the request, pre-treatment, such as aeration treatment and biotreatment, could be skipped by drawing water downstream of the dam to take advantage of contact with the air forcibly discharged from the dam and the river's self-cleansing effect.
- The west coast and east coast of the Arenillas River were considered for the site of the treatment plant. The east coast was selected for its greater ease of construction and the lower cost of pump operations.
- Since Huaquillas is characterized by flat terrain facing the ocean, the construction of four service reservoirs (overhead tanks) in the city was requested, but it was decided to supply water using the natural downward flow within the city to minimize the use of pumps.

Table 3: Output Provided through Grant Aid Cooperation (Planned/Actual)

Item	Planned	Actual
Water treatment plant	1) Water intake facility One gate, one storage shed renovation,45Kwx3 (110L/sec) pumps, installation of three new pumps, two control panels (one existing and one new), one suction pipe and internal pipework)	As planned
	2) Equipment introduced (water intake facility – water treatment plant) dia.300mm, 270m, DIP	47 air bulbs, one more than planned
	3) Water treatment plant: 100L/sec (8,640 m^3/day) Receiving well (2m×2m×3m), flocculation basin (4m×37.4m×1.7m), chemical sedimentation basin (5.3m×14.75m×3m; 2 basins), high-speed filter (4.2m×3.1m, 13.02m^2; 6 basins), transmission pumps (6.5m×14m; one-story pump), purification basin (20m×30m×3m, two basins, also used as service reservoir), outdoor drying bed 5.5m×12m×1m, four basins), administrative building (13m×20m, one-story, one chlorine room and one electricity room), chemical injection materials (aluminum sulfate, hydrated lime, two sets), chemical injection materials (pre-, intermediate- and after-chlorination	As planned
	4) Transmission facility (water treatment plant – Arenillas service reservoir) dia.250mm, 1,180m, PVC	1,080 m, 100 m less than planned; 35 drain bulbs, one more than planned
	5) Arenillas service tank 12m×14m×3m; one 500 m^3 tank	As planned
	6) Emergency power generator (675kVA) -Diesel power generator, fuel tank	As planned
	7) Civil engineering and architectural construction Water conveyance and service/transmission pump room, chemical injection building, filter management building	As planned
Water service in Huaquillas	1) Huaquillas water service tank: two 1,800 m^3 tanks 20m×30m×3m in dimension, also used as a treatment basin 2) Huaquillas water service pipes: dia.500mm, 19,860m, DIP 3) Huaquillas city water service pipes: dia.250mm–500mm, 5,020m, PVC/DIP	Water service pipes are 19,940m in length, 80m longer than planned. Water service pipes within the city are 4,670m, 350m shorter than planned.
Technical guidance	Technical instruction on maintenance and management for operating and maintenance staff	As planned

Source: Basic Design Study Report, materials provided by JICA, questionnaire

Moreover, in order to simplify maintenance and management, a decision was made to avoid using machinery that would require operating and maintenance inspections and repairs, and only the bare minimum of measuring devices and no electric measuring devices were installed. Specifically, the maintenance and management plan did not call for equipment requiring complex maintenance and management, such as internal transmission pumps and sludge collectors, and instead, called for water regulating valves that could be opened and closed by hand for easy operation.

The modest specification changes shown in the "actual" column in Table 1 were due to revisions based on accurate measurements when a detailed design was prepared in the case of the water pipes and water service pipes, while the change in the number of valves was due to adjustments in the water pressure as a result of the difference in elevation. Both were modest adjustments made to conform to actual conditions when the detailed design was drawn up.

Table 4: Output Provided by Ecuador (Planned/Actual)

Planned	Actual
Acquisition of land planned for use for water treatment facility	As planned
Construction of access road	As planned
Laying of electrical wires, electric transformer	As planned
Fence around water treatment plant's environs	Not implemented yet

Source: Basic Design Study Report, questionnaire, interviews with EMRAPA

3.4.2 Project Inputs

3.4.2.1 Project Cost

Japan's costs amounted to 2,043 million yen (49 million yen for the detailed design, 109.758 million yen for supervision of works, 1,895 million yen for the work and construction), which is 99.8% of the original estimation, is mostly as planned.

Ecuador's contribution amounted to 105,183 dollars (9,000 dollars for land acquisition, 2,000 dollars for access road upgrades, 94,183 dollars for electrical wiring and electric transformers).

The differences between the estimates for Japan's contribution and the actual amounts were primarily the result of greater detail in the design once the detailed design was prepared, and were not the result of changes in the plan.

The measures necessary by the Ecuadorian side for land appropriation and repairs to the access roads were taken and there were no problems. Fences for the water treatment plant were not constructed since the two cities did not recognize urgency of the fence construction. According to EMRAPAH, there had not been any problems thus far as a result of a lack of fences.

3.4.2.2 Project Period

The project period was 37 months, from the signing of the E/N on the detailed plan in January 2006 to February 2009. Although the environmental impact evaluation and approval took time, there were no delays, and the project duration was 97.6% of its original estimation, which is shorter than planned.

Both project cost and project period were within the plan, therefore efficiency of the project

is high.

3.5 Sustainability (Rating: ①)

3.5.1 Structural Aspects of Operation and Maintenance

3.5.1.1 Organizational Structure

This project was an initiation of the establishment of EMRAPAH[9]. The two cities reached agreement in May 2004, and the agreement was signed on June 2 of the same year. The mayors of Arenillas and Huaquillas take turns as president of EMRAPAH, with the Arenillas mayor currently serving as the president. The administrative board is made up of two people each from the city council members of Arenillas and Huaquillas. The board chairman is sent from the National Secretariat for the Water (Secretaria Nacional del Agua: SENAGUA).

The Arenillas office[10] is in charge of managing the regional water treatment plant built in this project The Arenillas office is the principal office, which also handles financial information, including that for the Huaquillas office[11]. User registration and record keeping, water charge collection are handled by respective offices independently with no integrated management between the two offices.

The new constitution revised in 2008 requires ordinance of a public company to clarify a role of the state government and to show a right number of board member according to the constitution. Consequently, revisions to the ordinance founding EMRAPAH were prepared in March 2008, and Huaquillas formally decided to authorize the revised ordinance with one revision on August 1, 2010. However, in November 2010, Arenillas requested five revisions in the articles so that the water distributed from the regional water treatment plant would be equally divided. At the time when this evaluation was carried out, the two cities had not agreed to the revised ordinance, and the organization remained in place without an updated EMRAPAH ordinance.

As mentioned in the later section, there have been very serious discussions among the stakeholders over split-up of EMRAPAH. If the split-up of the company is decided, extensive restructuring of the organization and reallocation of staff members according to new demarcation among the separated companies will be necessary. This situation gives a great uncertainty in the future if EMRAPAH will be able to maintain its ability of operational management of the regional water treatment plant and other facilities.

A closer look at how and why this problem developed shows that the two cities do not have a public agreement on dividing the water in a 3:7 ratio between Arenillas and Huaquillas. When the project's basic design study was carried out, the Japanese construction consultant proposed this water distribution ratio as a pre-condition for the design, and the cities essentially agreed to the water distribution when they agreed to the basic design. However, currently, the Arenillas mayor bases his contention that the water should be divided equally on the fact that there is no tangible agreement document on this 3:7 water distribution ratio. Given that other parties involved cannot contest this, it is fair to conclude that consensus-building on water distribution in this project was not well established.

[9] Usually in Ecuador, a municipal government has responsibility of water supply in a city, and before the establishment of EMRAPAH, the two cities operated water supply service independently.

[10] In charge of management of the Loma Quito water treatment plan; the city's water supply network; and the city's users and collecting water rates.

[11] The Huaquillas office is in charge of chlorine injection for the city, pump sites, the seven wells in the city, managing the water supply network within the city, managing Huaquillas users and collecting water rates.

The EMRAPAH administrative board has not been able to find any solution to these problems of water division and amendment of the EMRAPAH ordinance.

Both cities' mayors at least agree on the future of EMRAPAH that it should be self-supporting. In 2011, Arenillas independently hired a consultant to analyze current conditions of water supply service of EMRAPAH, and, as a result, proposed that the waterworks operations should be divided into (1) a water intake and treatment operation, (2) Huaquillas water distribution operation and (3) Arenillas water distribution operation, to be run as respective independent businesses. The Arenillas mayor agreed with the proposal to break up the operation, but asserts that Arenillas should have control over the regional water treatment plant. Discussions were held with the mediation of the Ministry of Urban Development and Housing (Ministerio de Desarrollo Urbano y Vivienda, MIDUVI) on May 10, 2012, during the on-site study period of this evaluation, and steps were taken to begin resolving this problem, but the outlook cannot yet be predicted.

Moreover, lack of integrated management of finance between the two offices of EMRAPHA, lack of holistic information management, lack of standard format of official documents are also challenging issues for appropriate coordination between the two offices.

3.5.1.2 Personnel Appointments

The appointment of the current EMRAPAH manager, who has the overall responsibility of EMRAPAH operation, ended in July 2011. However, due to the delay of revision of the EMRAPAH ordinance, the manager must remain in employment without any steps being taken for the manager's re-appointment or for the selection of a successor.

With regard to the personnel who work for the facilities constructed by the project, three people work at the water intake pump site, eight at the water treatment plan (of which one is an inspector) and two in the water quality testing room, with job rotations also carefully prepared and job records taken. This personnel system for the operation and maintenance of the water treatment plant has not led to any obstacles.

Huaquillas now has two staff members for water charge collection, and plans to hire two more. It was estimated that each staff member could deliver water bills to 100 users a day on average, but this has not been achieved. Rather, users receive water bills at a pace of about one every six weeks. Arenillas office has three staff members for water charge collection, and each staff member delivers the bill to about 70 users a day, which is better than the situation of Huaquillas but still need more recruitment.

Regarding the organizational structure, the wells that provide water for Huaquillas are all on privately owned land, and land rent is not claimed by the owner and is not paid. The rent can be claimed by the land owners in any moment of the future, and this implies that EMRAPAH has to rely on a basic infrastructure, which is not under their control, and EMRAPAH recognizes that it will be a source of concern in the future.

A more significant problem that EMRAPAH also recognizes is the weakness in technology and knowledge on management. EMRAPAH does not prepare annual plans or medium- and long-term plans. This is partly due to problems with the individual staff, but failure to ensure the organization's sustainability is the also a main factor behind this. As a result, the decision-making and command control structure remains ambiguous, with no steps taken to improve organizational management. In particular, this impedes the collection and management of information and data, with the exception of that related to the water treatment plant, such as water quality, water pressure, user records, charge collection, and leads to a negative cycle in

which the materials needed for decision-making in management cannot be obtained. If this negative cycle is not well addressed, EMRAPAH will have difficulties in preparing variety of plans such as renewal of facilities, production increase to meet increasing demand and improvement of finance through water fee rate revision and betterment of charge collection.

As such, there are still major organizational problems, and discussion on the future structure of EMRAPAH ignited by revision of its ordinance to be in accordance with the new constitution is moving toward split up of the company. Due to these situations, there is a good possibility that EMRAPAH will have a significant scale of restructuring of the organization and reallocation of staff members, which lead to possible changes in operational system of the regional treatment plant constructed by this project.

Given these factors, it is fair to conclude that organizational sustainability has many problems.

3.5.2 Technical Aspects of Operation and Maintenance

Eight operators run the water treatment plant in line with the operating manual, which runs without problems. Water quality tests are carried out daily at the water treatment plant, and a report is prepared on a weekly basis. There are no problems with the procurement of test reagents and other materials. In recent years, water has also been tested for microorganisms and heavy metals, but there is not enough testing equipment for this.

Data on the amount of water supplied and water quality at the water treatment plant is collected and managed regularly. However, information is not managed appropriately at EMRAPAH overall, so the Arenillas office and Huaquillas office do not share information with each other and the necessary information cannot be immediately retrieved.

Four staff members at the water treatment plant (two in the water quality testing room and two in operations) received technical guidance in this project. Of these, one staff member each from the testing room and operations has left their jobs, but this has not led to technical difficulties for the daily operation and the basic maintenance of the regional treatment plant.

In order to maintain the effect of the project including increased water supply hours and better water quality, not only the constructed water treatment plant, but also Loma Quito and wells in Huaquillas should be properly managed and maintained. Arenillas' Loma Quito water treatment plant and managers of the wells in Huaquillas receive technical support from the regional water treatment plant built as part of this project as necessary and information is shared within EMRAPAH to maintain and raise technical strength. As a result, there are no problems with normal operations at these existing facilities.

This project did not provide intensive technical training other than simple instruction on operation of the provided facilities when the plant was constructed, but reliable water supply and regular water quality inspections continue. No major problems were observed with the technology needed to manage the water treatment plant.

3.5.3 Financial Aspects of Operation and Maintenance

3.5.3.1 Balance of Income and Expenditure

EMRAPAH's revenue consists, roughly, of the collection of fees from users, supplementation from the city government and grant from the central government. The subsidies from the central government are paid out through the city government. The two cities share the operating costs for the intake pumps equally, and Arenillas pays 30% and Huaquillas

70% of the operating costs for the water treatment plant in line with the water distribution ratio. The annual income and expenditure data is shown in Table 5. Arenillas tends to have a deficit and Huaquillas a modest surplus, but overall this fluctuates significantly every year. EMRAPAH relies on external funds from the cities and the central government for more than 50% of its total revenue. The central government provides certain amount of money to EMRAPAH every year through the municipal governments and two cities have obligation to make up deficit of EMRAPAH. EMRAPAH's finance is managed by office-basis, meaning that each office in Arenillas and Huaquillas has an independent account book, and two cities are supposed to make up deficit of respect offices (Article 100 of the EMRAPAH ordinance states that the cities must cover EMRAPAH's losses). However, as demonstrated in the figures for the "city government's contributions" and "central government subsidies" in the table, city contributions and subsidies from the central government fluctuate significantly, which is a major factor behind the upward and downward volatility in annual revenue. Arenillas office experienced deficit for three years in the past five years mainly due to shortage of these external income, and Huaquillas also has been in trouble since 2009. Internal revenue, which comes from water charges, is on the rise, but at present a stable revenue source has not been secured.

Moreover, the fees collected (item 1 of table 5) include a 10% fee for contributions to water source conservation, but there is no organization in central government either in local government, which is responsible for water conservation. This money is merely retained by EMRAPAH essentially as a deposit, but it is not clearly earmarked on the book. This means actual revenue of the company is 10% less than it shows on the table and the actual deficit is larger. In addition, total uncollected water charges (including interest on arrears, item 2 of table 5) carried over from the period prior to EMRAPAH's establishment amounts to about 2 million dollars on Huaquillas' books, but 800,000 dollars of this consists of fees charged to users that do not exist as a result of mistakes in user records. This means that the actual amount is about 1.2 million dollars. The collection of delinquent fees accounts for quite a large percentage of their income, about 20 to 30$ for Huaquillas and more than 20% or even nearly 50% in some year for Arrenillas. This means that reliance on revenue that was not accrued in that fiscal year is high, or large amount of account receivable are not collected within the fiscal year. This is not a desired situation as healthy financial management.

Table 5: EMRAPAH's Finances Since 2007 (Unit: US dollar)

		2007	2008	2009	2010	2011
1. Revenue from charges	Arenillas	9,601.59	57,883.66	106,118.94	127,436.95	200,906.32
	Huaquillas	34,499.44	101,494.12	174,858.28	278,367.32	332,422.02
2. Collection of unpaid charges	Arenillas	54,035.70	88,967.86	89,789.24	122,369.47	102,545.82
	Huaquillas	149,638.38	144,176.67	162,190.63	217,598.53	346,422.24
3. Contribution from city government	Arenillas	90,464.52	139,413.70	128,223.21	153,051.16	91,988.59
	Huaquillas	26,945.00	26,875.89	6,500.00	12,000.00	0.00
4. Subsidy from national government	Arenillas	71,145.40	145,296.65	6,520.36	191,834.61	15,987.50
	Huaquillas	214,151.47	363,307.71	0.00	577,459.19	0.00
5. Total revenue from outside (2+3)	Arenillas	161,609.92	284,710.35	134,743.57	344,885.77	107,976.09
	Huaquillas	241,096.47	390,183.60	6,500.00	589,459.19	0.00
	Sum	402,706.39	674,893.95	141,243.57	934,344.96	107,976.09
6. Total revenue (1+2+5+other revenue)	Arenillas	226,658.31	434,434.93	313,038.19	600,282.99	427,825.07
	Huaquillas	431,973.63	637,438.96	351,891.20	1,088,871.48	747,592.95
	Sum	658,631.94	1,071,873.89	664,929.39	1,689,154.47	1,175,418.02
7. Total expenditure	Arenillas	208,318.20	446,930.48	472,083.91	500,166.50	529,030.42
	Huaquillas	262,165.90	557,978.10	646,706.88	1,032,708.75	708,256.30
	Sum	470,484.10	1,004,908.58	1,118,790.79	1,532,875.25	1,237,286.72
8. Revenue and expenditure	Arenillas	18,340.11	-12,495.55	-159,045.72	100,116.49	-101,205.35
	Huaquillas	169,807.73	79,460.86	-294,815.68	56,162.73	39,336.65
	Sum	188,147.84	66,965.31	-453,861.40	156,279.22	-61,868.70

Source: Basic design report, information obtained from questionnaire and in interviews to EMRAPAH

EMRAPAH has several new projects including renovation of Loma Quito treatment plant and construction of water tanks and they require investment money. Considered this demand on the future funding, current financial situation of EMRAPAH is not regarded as stable. Considering the current shortage of budget to repair the Loma Quito water treatment plant and to build new elevated tanks in Arenillas and the ongoing discussions on split-up of the company, possibility that the financial situation of EMRAPHA is getting better seems to be low.

3.5.3.2 Fee Collection

Table 6 provides current water charges.

Charges are levied based on the readings in cases in which houses are equipped with water meters, while a basic rate is charged for houses not equipped with water meters, but in reality all users are only charged this basic rate. Some are of the opinion that the amount of water that can be used for the basic rate, stipulated in the rates table as 23 cubic meters, is too high, but this is because rates are not charged based on meter readings. In Huaquillas, rate collection at a metered rate has been started on a trial basis with 200 households, and Arenillas wants to start a similar trial.

Data on the non-revenue water could not be obtained since data on water usage on the user side is not collected. Accordingly, the data needed to devise financial plans including rate of non-revenue water, cannot be compiled.

The payment rate remains about half. Steps are being taken to raise the payment rate, such as handing the rate collection slip directly to the user, stopping water services for those who are delinquent in paying their water charges, and requiring proof that water charges have been settled on the property in question when city government authorizes real estate transactions.

Table 6: Water Charges (Unit: US dollar)

Category	Private homes	Commerce	Industry	Government
Basic usage amount (m^3)	23	50	75	30
Unit price for usage above basic usage amount (cent/m^3)	0.12	0.2	0.4	0.06
Basic charge (USD)	2.76	10	30	1.8
Fixed fee collection (USD)	1.5	2	3	0.75
Fee for preservation of Arenillas River valley (10% of basic charge, USD)	0.276	1	3	0.18
VAT (USD)	0.25	0.75	1.5	0.15
Total cost (For basic usage amount)	4.79	13.75	37.5	2.88

Source: EMRAPAH

3.5.4 Current Status of Operation and Maintenance

The on-site investigation carried out as part of this evaluation study confirmed the following about equipment and facility conditions.

① Condition of the regional water treatment plant

- All three regulators for chlorine gas injection broke down about one year after they began to be used, and were replaced for 3,000 dollars each. However, one of the new regulators broke down. Thus intermediate injections are not being carried out now.
- The conditions of equipment other than the aforementioned chlorine gas regulators are good.

② Condition of the intake

- Cracks have formed on the floor and walls of the intakes and the regional water treatment plant's pump room, as well as on the outer wall of the distribution water tanks.
- There is a risk of collapse of the slope behind the intake pump house due to improper protection of the slope.
- The water channel leading from Arenillas River's reservoir to the intake is not well maintained. In some cases, places in which the structure has collapsed and those in which large amounts of sediment, such as sand from the slope, has collected in the channels have been left unattended. EMRAPAH is aware of this problem and estimates that it would cost 100,000 dollars to fix, but there are no prospects for raising this money.
- On only one occasion the water gate for irrigation water intake was closed to prioritize the supply to the treatment plant when the water level in the Arenillas River felt during the dry season. However, there were no other problems with water intake.

Gradient of backside of intake

Conduit to intake

③ Conditions in Arenillas

- One of the reasons why the objective of the project, 24-hour supply of water, was not achieved in Arrenillas is the existence of some areas, which elevation is high and water pressure from the regional plant was not good enough. Stable supply of clean water to these areas can be realized by upgrading of Loma Quito water treatment plant. Arrenillas city has been considering upgrade of water pipes and construction of additional elevated distribution tanks. EMRAPAH states that this would cost 800,000 dollars, while the Arenillas mayor maintains that 1.5-2 million dollars would be needed, and there has been no official earmark for these expenditures in budget plan of the city government.

④ Conditions in Huaquillas

- The floor of Huaquillas' chlorine injection facility was leaning in 2010 and was repaired. Subsequently, cracks were observed in the surrounding surface.
- The basic design of the project was prepared based on a precondition that the existing wells produce more than 40 litters/second of water so that total amount of water supplied to Huaquillas meet the demand of the city. At least three wells have to be operated to satisfy this precondition. Existing wells in Huaquillas pump over 15 liters/second at present. The water supply from existing wells is not stable due to changes in the level of water table as well as suspensions of pump operations as a result of replacement of decrepit parts and delinquent electricity fees. Moreover, of the seven wells, PH7 is not operating due to problems with water quality, and PH1 and PH4 are not in operation because, respectively, replacement parts are being awaited and electricity fees are in arrears.

⑤ Other

- The fiscal 2011 subsidies from the central government were to be used for the work to install valves in Arenillas (95,000 dollars) to control water pressure, and work to repair existing wells in Huaquillas (387,000 dollars) to maintain the total water supply capacity, but the two cities were behind in providing the funding (17,800 dollars from only Arenillas) and the plan could not be implemented. These measures are necessary for future realization of the original project target of 24 hours water supply.
- There are problems with the user registration database, which is indispensable for charge

collection. Revisions were made to ensure consistency with the city hall's resident records, but there are multiple records for the same person and records of users who do not exist, and records are not updated to reflect name and land ownership changes. As of Sepptember 2012, Huaquillas has finished revising about 85% and Arrenillas finished 80% of their records.

The defect inspection made some recommendations on facility operations and maintenance, and at the time of this evaluation, these recommendations have generally been addressed without problems except the "install an electrical stabilizer in the water intake to prevent defects of the control panel for the pumps." This has not been done. There have not been any problems thus far, but EMRAPAH recognizes that it must be installed soon.

As noted above, there were signs of aging in some of the facilities of the project, but nothing that would cause major problems. The cause of the breakage of the chorine injection regulators is unknown, but replacements were bought through their own efforts. One of these broken down and a replacement has not been ordered, but there are no problems with chlorine concentration so it does not seem to be having a severe impact.

At the same time, there are points requiring improvement, including protecting the gradient of the slope to the rear of the intake pumps and upgrading the channels leading to the intake pumps. In addition, EMRAPAH has established its own individual plans to improve facilities, but these plans have not been implemented due to failure to procure funding. These difficulties in the maintenance and operation are also potential hindrance against the sustainability.

As shown above, major problems have been observed in terms of the organizational system and financial conditions, therefore sustainability of the project effects is low.

4. Conclusion, lesson Learned Recommendations

4.1 Conclusion

This project was implemented to realize 24-hour water supply in Arrenillas and Huaquillas, which are left behind for their socio-economic development due to the influence of the conflict over the border between Peru and Ecuador. This project is consistent with the priority areas in Ecuador's national development policies and Japan's aid policy, and is also very consistent with development needs in the target region. Accordingly, the relevance of this project's implementation is high. The project's costs and duration are both in line with the plan, indicating that efficiency is also high. The targets for clean and safe water production capacity have been achieved, but the goal to provide users with benefits such as 24-hour water supply was not achieved. Moreover, the anticipated economic and public health impacts did not materialize. For these reasons, the project's effectiveness is fair. There are major problems with organizational sustainability, such as lack of decision on the organizational approach for the local water utilities administrations in the cities of both Huaquillas and Arenillas, the project's implementing organizations. There are also financial issues. Thus the sustainability of the project's effects is deemed to be low.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency (EMRAPAH) and two city governments

- Agreement on the revised founding ordinance for EMRAPAH should be reached with all due urgency. Currently, differences in opinion between the two cities and their joint management of the shared water treatment plant and the two cities' multiple independent water sources makes for a very complex management environment for EMRAPAH's current administrative and management structure. Going forward, EMRAPAH should consider simplifying responsibilities and operations as much as possible. A proposal to split up EMRAPAH has been raised, and both cities have expressed interest in this proposal. Ultimately, this should be decided based on a consensus reached between the two cities and the current public corporation, but MIDUVI should facilitate discussions as the intermediary to ensure that there is a forum in which to pursue concrete issues.
- Optimizing the method by which the two cities provide financing should also be considered when the EMRAPAH ordinance is revised. Currently, financing is supposed to be provided by covering the annual loss by the two cities. Since amount of money for the covering can be different year by year, it makes it difficult to prepare medium- and long-term financial plans for EMRAPAH and the cities. One approach would be to set a medium- to long-term schedule for EMRAPAH to achieve financial independence and then provide an amount determined in advance in line with this schedule. Whatever method is adopted, one that would stabilize EMRAPAH's finances, which enable it to strengthen the service, should be established.
- The system for compiling and managing management information, such as user records, connection records, payment books, meter installation and maintenance records, and water use records should be redeveloped to provide necessary information for the mid and long term operation plan.
- The channel leading to the intake pump house should be upgraded to prevent from blockage of the channel in future.
- Both cities need additional water sources rather than the water from the regional treatment plant to supply enough water to the cities. Water from the regional plant and water from the other water sources are mixed in the distribution pipes in the cities, and amount and quality of the water from the additional water sources directly influence the effect of the project. Therefore, proper management of the additional water sources is very important for the sustaining the effect of the project. In order to secure enough safe water for the cities, strengthening of maintenance activities to rehabilitate the Loma Quito water treatment plant in Arenillas and ensure stable operations of the existing wells in Huaquillas are indispensable.
- In some part of Arrenillas, the water is delivered directly from the water intake without any treatment. Also, due to the above mentioned reasons of instable water supply from the other water sources, there are some areas, where quality of water may be inappropriate. Regular water quality test should be conducted to understand the real situations in these areas, and correct information on the safety of the water should be provided to the users.

4.2.2 Recommendations to JICA

JICA should consider the possibility of technical support on the management side, such as help establishing medium- and long-term plans and financial plans, customer management, and

information management, on the condition that revisions to EMRAPAH's founding ordinance are completed. Failure to fully acquire these management techniques could pose significant risks to the sustainability of the project's anticipated effects.

4.3 Lessons Learned

① Cautious assessment in preparing for acceptance of implementing organization

It is extremely risky to start projects characterized by a complex political and administrative context, such as collaborative projects involving multiple organizations like this project, when the counterpart organization has not been established or not yet been operational in full scale. The timing for the project's start should be cautiously assessed. If possible, it should not be started until the establishment of the counterpart organization has been confirmed in writing, at the very least. Moreover, even after the project has been started, the project should be monitored for risk management to determine whether the formal establishment of the counterpart organization is proceeding as planned and it is equipped with technical and management capacities.

② Importance of management techniques

In relation to the above mentioned assessment of acceptability of implementing organization, there is one aspect worth emphasizing. In the case of grant-aid cooperation, technology for facility maintenance is analyzed in advance, but consideration of management techniques enabling the executing organization to run the facility for its sustainable business, including ability to prepare mid-term and long-term plans and financial management is not always adequately considered. However, in the case of this project, there were no critical problems with the facility maintenance techniques, but inadequate management techniques have led to major problems in realizing the project's effect and impact and ensuring sustainability. Preliminary study should analyze management techniques for carrying out business operations using the facility, and not merely techniques for running the facility, and necessary actions should be incorporated into the project plan.

③ Forming a separate consensus on important issues

Water allocation between regions is extremely important in water supply projects. In this project, water allocation between the two cities was stipulated as a premise in the basic design report and the two cities signed a comprehensive agreement on the substance of the basic design. Nevertheless, a consensus document on water allocation was not prepared. This lack of a consensus document on water allocation is one of major factors that is currently complicating efforts to resolve problems between the two cities.

The basic design study for the grant aid cooperation project laid out proposals for the many important issues to be considered, and the stakeholders' consensus on the basic design could be seen as an agreement on all of the proposals included in the design. However, the donor side should also be sure that an independent agreement document should be signed to ensure consensus on important areas that could be contested in the future. Alternatively, making such establishment of written agreement on critical issues among the stakeholders a pre-condition of the project implementation could be another possibility. In any cases, careful consideration on necessary conditions for the success of the project should be made at planning stage.