Cooperative Republic of Guyana

Ex-Post Evaluation of Japanese Grant Aid Project

Project for Water Supply in Corriverton (Phase I and Phase II)

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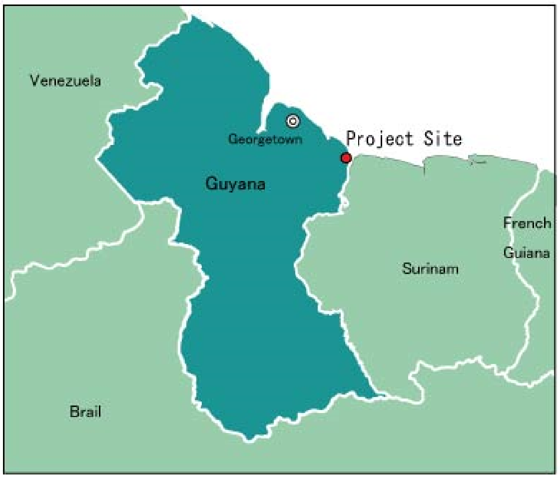
0. Summary

The Project was implemented to improve the water supply service in Corriverton in Guyana by means of rehabilitating the existing water source wells, constructing new Water Treatment Plants (WTPs), laying conducting and distribution main pipelines and procuring water meters. The supply of safe water has always been a priority issue in the national plan of Guyana. The expansion of areas receiving treated water is still a pressing task in coastal regions and the need for the Project is very strong. As the Project was in line with Japan's ODA policy, the overall relevance of the Project was high. At the WTPs constructed under the Project, iron in the raw water is now removed. However, coliforms are sometimes detected in the treated water, indicating that the safety of the water or capacity for water testing is in question. Partly because of the slower-than-planned progress of the reduction of the water demand to correspond to the treatment capacity of the WTPs, the size of the population receiving treated water at the time of this ex-post evaluation is some 60% of the planned size. Meanwhile, the installation of water meters and progress of leakage control have increased the water pressure throughout the project area, improving the convenience of water use along with an improved water quality due to the removal of iron from the raw water. The Project has somewhat achieved its objectives and its effectiveness and impact is fair. Because of problems with the tender due to the unexpectedly high price hike of construction materials and equipment, the completion of the Project was delayed by one and a half years from the originally planned completion date. As the project cost also exceeded the original plan, the efficiency of the Project is low. The institutional and financial aspects of the operation and maintenance of the facilities constructed under the Project are adequate. Although an outbreak of algae occurred at one of the WTPs with slow sand filter bed, technical capability to ensure the required quality of the treated water by means of employment an alternative means of algae control is available. As such, the sustainability of the Project effect is high. In light of the above, this Project is evaluated to be partially satisfactory.

1. Project Description



Project Location

Queenstown WTP

1.1 Background

The Cooperative Republic of Guyana (hereinafter simply referred to as “Guyana”) is located in the north-western part of the South American continent facing the Atlantic with a population of 751,000 (2002 Census data). Its national economy is mainly dependent on agriculture, forestry and mining industries.

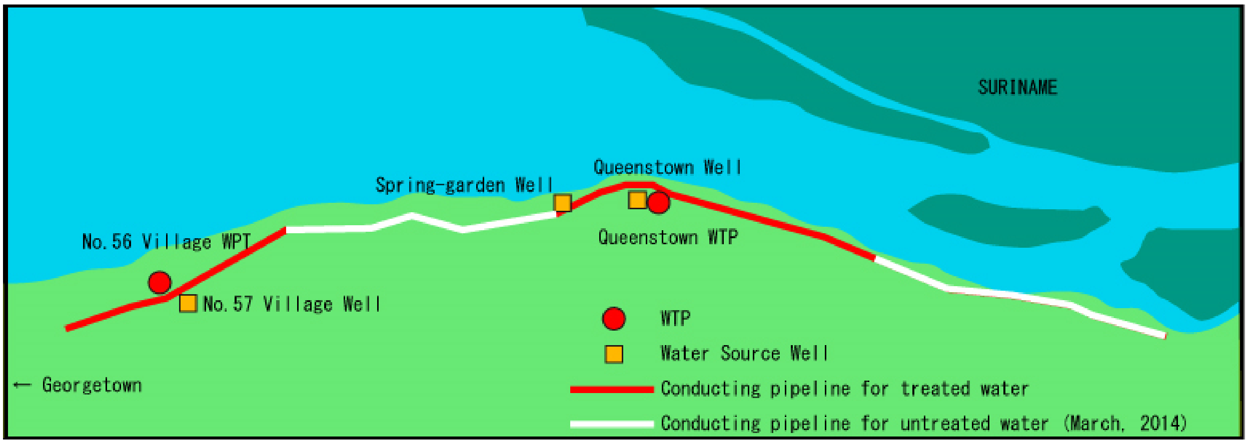
Guyana has set forth the National Development Strategy (2001-2010) and the Poverty Reduction Strategy Paper (PRSP) (prepared in 2001), both of which emphasise the improvement of social infrastructure, especially the supply of safe water. The priority targets for implementation by 2010 in the medium-term strategy of the government were i) supply of safe water to 95% of the population, ii) establishment of a nationally integrated water supply corporation, iii) intensification of water supply projects in coastal areas with emphasis on water purification and iv) implementation of a comprehensive rehabilitation and maintenance plan.

Guyana Water Inc. (hereinafter referred to as ‘GWI’), which uniformly provides water supply and sewerage services nationwide, was established in 2002 and its water supply operations were placed under the jurisdiction of the Ministry of Housing and Water. In 2003, the national average coverage of the water supply service was higher than 80% but insufficient disinfection meant a high risk of bacterial infection. At the same time, the high level of iron in the water had been causing such unpleasant effects as a strange odour/taste and the reddish discoloration of clothing. Because of the country’s mainly flat topography, the employment of a gravity system was difficult, and the direct supply system from water source well pumps had been suffering from a problem of insufficient pressure depending on the location and/or time. Another problem was restricted supply hours because of the need to save the cost of electricity required to operate the pumps. Moreover, the low water meter installation rate meant that (i) users tended to waste water as many of them were not charged in accordance with the water consumption amount and (ii) it was practically impossible to estimate the quantity of non-revenue water, including leaked water, as no measurement on water consumption were available.

Under these circumstances, the Government of Guyana requested Japan for grant aid for the Project for Water Supply in Corriverton in August, 2003 for the purpose of improving the water supply situation in Corriverton (population of 31,000 in 2005) on the eastern coast of the country.[1]

1.2 Project Outline

The Project aimed at improving the water supply service in Corriverton in Guyana by means of rehabilitating water source wells, constructing new water treatment plants (hereinafter referred to as ‘WTPs’) (consisting of a slow sand filter bed, distribution pond, elevated tank and chlorination facility, etc.), laying new conducting and distribution main pipelines, procuring water meters and technical transfer on operation of slow filtration water treatment plants.



Location Map of Project-Related Facilities

[1] The Project for Water Supply in Corriverton was implemented in two stages. However, the construction work in Stage 2 did not take place because of an unsuccessful tender with only the detailed design, support for the tender and soft component executed in Stage 2 (see the section on Efficiency for further details). Subsequently, the Project for Water Supply in Corriverton (Phase II) was implemented after the feasibility study which was needed to re-examine the contents of the detailed design and quantity survey.

Grant Limit / Actual Grant Amount	Project for Water Supply in Corriverton (Phase I, Stage 1) 651 million yen / 647 million yen Project for Water Supply in Corriverton (Phase I, Stage 2) 725 million yen / 31 million yen Second Project for Water Supply in Corriverton (Phase II) 867 million yen / 809 million yen
Exchange of Notes Date	Project for Water Supply in Corriverton (Phase I, Stage 1) July, 2006 Project for Water Supply in Corriverton (Phase I, Stage 2) June, 2007; (Extension) March, 2008 Second Project for Water Supply in Corriverton (Phase II) January, 2009
Implementing Agency	Guyana Water Inc. (GWI)
Project Completion Date	Project for Water Supply in Corriverton (Phase I, Stage 1) March, 2008 Project for Water Supply in Corriverton (Phase I, Stage 2) April, 2008 Second Project for Water Supply in Corriverton (Phase II) October, 2010
Main Contractor(s)	Project for Water Supply in Corriverton (Phase I) Kitano Construction Corp. Second Project for Water Supply in Corriverton (Phase II) Tokura Corporation
Main Consultant(s)	Tokyo Engineering Consultants Co., Ltd.
Basic Design Study	November, 2005 to March, 2006
Related Projects (if any)	Implementation Review Study: July to November, 2008

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan)

2.2 Duration of the Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Duration of the Study : September, 2013 to October, 2014
Duration of the Field Survey: 18th to 30th November, 2013, 12th to 16th March, 2014

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

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance to the Development Policies of Guyana

As already mentioned in 1.1 Background of the Project, the supply of safe water was emphasised by the national strategy, etc. at the time of the ex-ante evaluation. As part of this emphasis, the expansion of water treatment for water supply was a priority in coastal areas.

The Poverty Reduction Strategy Papers revised in 2003 aimed at increasing the supply quantity of treated water in coastal areas along with the achievement of the supply of safe water to 95% of the population by 2015 while emphasising the rehabilitation and proper maintenance of the existing facilities. The Millennium Development Goal monitoring report for Guyana (2011) indicated that 94% of households had access to safe water and that 92% of the population had access to water supply. In inland areas, however, only 52% of the population had access to safe water, suggesting a large gap between coastal and inland areas. Because of this, at the time of the ex-post evaluation, priority is rather an increase of the water supply coverage in inland areas.

As described above, while the supply of safe water was still emphasised by the national strategy, etc. at the time of the ex-post evaluation, priority is given to an increase of the water treatment to produce safe water in inland areas in view of the much progress made in the supply of safe water in coastal areas.

3.1.2 Relevance to the Development Needs of Guyana

As already mentioned in 1.1 Background, the Project intending to spread the use of water meters and to improve the water treatment rate was relevant to the development needs of Guyana at the time of the ex-ante evaluation.

Interviews with GWI officials found that the primary challenges faced by the GWI at the time of the ex-post evaluation were the further spread of the use of water meters, improvement of the profitability through a reduction of the water leakage and improvement of the water

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

treatment rate.[4] In Corriverton, while the water supply coverage and metered household rate had reached 100% and more than 90% respectively at the time of the ex-poste evaluation, the water treatment rate was still as low as 58% (see 3.2 Effectiveness for further details).

One drawback was the failure to achieve a reduction of the water demand as assumed by the basic design study. Because of this, the supply of untreated water was necessary in some areas at the time of the ex-post evaluation (see 3.2 Effectiveness for further details). It can be pointed out that the reasons for this failure could have been (i) an under-estimated water demand by the GWI which was used as a criterion for the basic design and (ii) insufficient consideration of the risk relating to the delay of leakage control measures as well as water meter installation, which was a precondition for fostering the awareness of water users of the need for water saving. However, as the plan put forward by the basic design study team also included an assumed case of the water demand not being sufficiently reduced in a short period of time, it cannot be said that the plan for the Project was not sufficiently relevant to the development needs of Guyana.

Based on the above, it is safe to conclude that the Project was relevant to the development needs of Guyana at the time of both the ex-ante evaluation and ex-post evaluation.

3.1.3 Relevance to Japan's ODA Policies

At the time of the ex-ante evaluation, Japan set itself the task of providing grant aid and technical cooperation for improvement in areas of basic human needs and contribution to poverty reduction in Guyana from the viewpoint of "poverty reduction" which is one of the priority issues of Japan's ODA Charter. To be more precise, the intended cooperation would primarily focus on those areas concretely referred to in the PRSP prepared by the Government of Guyana so that the Japanese cooperation would provide sufficient aid to meet the demand in reference to basic human needs and to contribute to poverty reduction as such aid was considered to be highly necessary.[5] Accordingly, the Project was relevant to Japan's ODA policies.

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.

[4] The Business Plan for the GWI (2012 -2016) aims at making the overall business profitable through an increase of the water meter installation rate and a reduction of non-revenue earning water. It also aims at improving the water treatment rate from 49% in 2012 to 80% in 2016.
[5] Japan's ODA Data Book for Guyana (FY 2006)

3.2 Effectiveness[6] (Rating: ②)

The objective of the Project was to achieve a continuous supply of safe water in a sufficient quantity for people (31,000 in 2005) in the project area. In this section, the quantitative effects of the Project are evaluated in terms of three aspects: i) operational status of facilities, benefitting area and benefitting population, ii) supply of safe water and iii) continuous supply of water in a sufficient quantity. In addition, the qualitative effects of meter installation and the introduction of a metered tariff, which are introduced to control the water demand, operation of a slow sand filter bed at WTPs and the soft component of the Project are also analysed as factors affecting the effectiveness of the Project.

3.2.1 Quantitative Effects (Operation and Effect Indicators)

3.2.1.1 Operational Status of Facilities, Benefitting Area and Benefitting Population

Upon completion, two new WTPs constructed under the Project began 24-hour operation. However, the volume of water treated at these WTPs fell short of the demand, resulting in a reduction of the service area and service hours. The reasons for this include the slow progress of the planned reduction of the water demand which was assumed by the water demand forecast at the time of project planning[7] and the shortage of raw water at No. 56 Village WTP that was caused by the diversion of raw water to a neighbouring area in order to cope with suspension of pumping operation at one of the water source wells located in a neighbouring area in the latter half of 2010. Treated water production volume at the two WTPs is shown in the Table 1 below.

Consequently, the service population of the two WTPs remains at 58% of the planned figure (5,211 households out of 8,992 households, approximately 23,000 people) as of March, 2014. In the areas not supported by these WTPs, the supply of untreated water from existing wells is continuing. The GWI currently plans to stop the diversion of raw water to neighbouring areas and to gradually expand the coverage of treated water supply in stages after the manifestation of the positive impacts in water saving by meter installation and reduction of the water leakage. As of March, 2014, work is in progress to freshly supply treated water to some 1,400 households by August, 2014. Depending on the actual outcome of this work, even though further expansion of the service area will be examined, it is unclear whether or not the entire project area can be covered by this further expansion.

[6] Sub-rating for Effectiveness is to be put with consideration of impact.
[7] See 3.2.4 Control of Water Demand Through the Installation of Water Meters and Other Means

Table 1 Treated Water Production Volume at WTPs in Corriverton

(Unit: m^3/year)

	2008	2009	2010	2011	2012
No. 56 Village WTP	1,314,000	1,095,000	740,000	866,400	862,879
Queenstown WTP	-	-	-	1,956,000	1,706,586
Total	1,314,000	1,095,000	740,000	2,822,400	2,569,465

Source: GWI

Based on the above, the achievement of the objectives relating to the benefitting area and population is judged to be fair. All of the water meters (8,400 units) procured under the Project has been installed throughout the project area at the time of ex-post evaluation, benefitting the entire project area in terms of water pressure, etc. as described later.

3.2.1.2 Supply of Safe Water

The original plan for the two WTPs constructed under the Project was to produce treated water by removing iron from raw water through oxidation by iron bacteria, slow sand filtration and chlorination.

According to the results of the daily iron level check which is conducted at each WTP, iron have almost completely removed. The test conducted at each WTP during the field survey found that the concentration of iron was below the detection limit. As the beneficiaries' survey reported that the supplied water no longer has a bitter taste or red colouring caused by the presence of iron, the intended removal of iron is believed to have been successfully achieved.

In contrast, coliforms which must not be detected in safe water is actually detected in one tenths of the sampled water from the two WTPs in question. Moreover, faecal coliforms which indicate the contamination of raw water as well as a risk of waterborne disease are found in several percent of the sampled water. As far as these test results are concerned, the treated water at these WTPs cannot be judged to be "safe water". According to the GWI, coliforms and faecal coliforms are detected in similar proportions at other WTPs in Guyana, indicating that the treated water at the two WTPs in question is not especially poor. The test on coliforms is conducted at a laboratory in Georgetown by transporting samples from each WTP. The GWI points out the possibility of the samples' contamination during the process of sampling at each WTP and/or during transportation to the laboratory. As such, the existence of coliforms in treated water has not been accurately established.[8]

[8] To strengthen its water quality testing capability, the GWI has begun the work to improve the laboratory in Georgetown, the capital of Guyana, to develop the water quality testing procedure, including the sampling and transportation of samples, and to train its staff.

As far as the test results of the sampled water at each WTP are concerned, the residual chlorine concentration is in the adequate range to suppress the propagation of bacteria in the treated water. However, it is suspected that the said concentration fluctuates to a certain extent as some residents during interview expressed the opinion that the residual chlorine concentration appears to be too high from time to time and should be lowered (17 out of 64 residents interviewed (27%) mentioned this).[9] 75% of the households receiving treated water purchase bottled water for drinking.

To sum up, the achievement level of the objective concerning the supply of safe water is judged to be fair.

Purified water
(No. 56 Village WTP)

Checking of the iron concentration using a reagent
(in an area receiving untreated water)

3.2.1.3 Continuous Supply of Water in Sufficient Quantity

① Improvement of the Water Pressure

According to the results of the beneficiaries' survey, 72% of the benefitting households say that the water pressure has improved.[10] This positive effect of the Project on the water pressure is observed by not only those households receiving treated water but also households throughout the project area. In some areas, the residents were forced to fetch water from another area before the Project. Since the project completion, however, supplied water reaches all households in the project area even though 28% of the benefitting households are still unsatisfied with the water pressure.

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[9] For the present ex-post evaluation, 100 households in Corriverton were randomly selected for the beneficiaries survey using a questionnaire (see the Box at the end of 3.2.5).

[10] As the water pressure fluctuates throughout the day (it drops when the demand is high), data which can be compared to existing data of which the time of measurement is unknown has not been obtained.

According to the GWI, an improved water pressure is the combined effect of (i) a restrained water demand due to the installation of water meters procured under the Project, (ii) reduced water leakage from connection pipes as a result of the work to install water meters accompanied with renewal of connection pipes and (iii) reduced water leakage from water mains, etc. as a result of the work conducted independently from the Project. It is inferred that water leakage in the past mostly occurred at the connection between main water pipes and the service pipes for each house. In the beneficiaries' survey, many residents said that the water pressure significantly improved after the water meter installation work.

② Improvement of the Water Supply Hours

Prior to the implementation of the Project, water was supplied in Corriverton for 12 hours a day by means of direct pumping from water source wells. The plan for the Project intended the provision of 24-hour water supply from water tanks installed at the two new WTPs. However, as of March 2014, the two WTPs are supplying water for 16 – 17 hours/day, failing to achieve the planned 24-hour water supply.[11]

According to the GWI, while the WTPs have the capacity to supply water 24-hours a day, they do not operate at full capacity because of concern regarding wasteful water consumption at night. Most households in the project area have a large water tank and often leave the tap open at night to store water in the tank. Meanwhile, there is also a local custom of hardly using any water after 7 o'clock in the evening. Accordingly, 24-hour water supply could lead to the loss of water as water may overflow from the tank when the tap is left open. The existence of water tanks means that people do not find it particularly inconvenient when there is no water supply at night.[12] In fact, the beneficiaries' survey found that many people do not consider 24-hours water supply to be necessary. Instead, many people complained about the irregularity of the water supply hours during the day.[13]

Residents welcome the fact that each WTP has eliminated the suspension of water supply during power outages by installing a generator at each well.

Based on the above, the achievement of the objective relating to continuous water supply in a sufficient quantity is judged to be fair.

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11 As of March, 2014, the No. 56 Village WTP supplies water from 05:00 to 21:00 while the Queenstown WTP supplies water from 04:00 to 21:00.

12 As people in Guyana used to store rainwater for domestic use, each household traditionally has a large water tank. Even in Georgetown, the capital, around the clock water supply is only available in some areas.

13 Even though there is a set water supply schedule, the actual water supply hours change almost daily depending on the volume of water available at each WTP.

Installed water meter — Water tanks installed at ordinary households

3.2.2 Qualitative Effects

3.2.2.1 Control of Water Demand through Installation of Water Meter and Other Means

Under the Project, 8,400 water meters were procured. The original plan was to install all of these by the completion of the Project in March, 2009 and the new regime of water charge collection based on the actual consumption volume was expected to substantially reduce the water demand. In reality, the number of meters installed was 2,170 by 2009 and 5,400 by 2010. In 2013, water meters were installed at more than 90% of the households in the Project area. The GWI explains that the main reasons for this delay of meter installation are that the contractors were too busy to install meters because of a nationwide construction boom and that there were non-residential house owners who were not present when an installer visits.

The general practice of the GWI is to start metered water charge collection upon the installation of the water meter in the new billing cycle. The beneficiaries survey found that 65% of the surveyed households had been trying to reduce their water use following meter installation. It is believed to have contributed to the reduction of the water demand along with the reduced leakage from connection pipes which are replaced as part of the meter installation work.

The delayed installation of water meters is a contributory factor for the non-accomplishment of the planned reduction of the water demand, restricting areas which receive treated water. Before the Project, the water supply volume per capita (daily water production volume divided by the number of people receiving water supply) was approximately 500 litres/day. Based on data from the WTPs and wells, the comparable water supply volume per capita in 2013 is estimated to be 381 litres/day. Even though the 2013 figure is much lower than the pre-project figure, it is still more than double of the figure of 180 litres/day assumed in the basic design study.[14]

Another factor contributing to the reduction of leakage is the strengthening of the executing agency's capacity for leakage reduction (see 3.5 Sustainability).

3.2.2.2 Operation of Slow Filtration Water Treatment Plants

① Outbreak of Algae and Control

At the No. 56 Village WTP, the slow sand filter is in operation as planned and biological treatment using iron bacteria is effectively removing iron from the raw water. In comparison, there was a major outbreak of algae at the Queenstown WTP immediately after its opening, deteriorating the water quality (bad smell and taste). Clogged filters mean a slower filtration speed. The operation of this WTP was also hampered by the long time required to drain water from the filter bed for sand scrapping operation which must be frequently conducted to maintain the function of the filter bed. The GWI tried various measures to remove the algae, but has not been able to find effective solutions. The GWI started to experiment with the physiochemical treatment process of injecting chlorine prior to filtration (hereinafter referred to as "pre-filtration chlorine injection") in mid2013. This process is not necessarily the correct process for the operation of a slow sand filter as the required amount of chlorine for injection is almost that the amount of post-filtration injection, making the process very expensive. Meanwhile, the quality of the treated water from the Queenstown WPT is similar to that from the No.56 Village WTP at the time of ex-post evaluation.

The reason why only the Queenstown WTP suffered an outbreak of algae possibly lies with the different quality of the raw water but this has not been clearly established.[15] In general, it is very rare for a slow sand filter using groundwater as the raw water to suffer from an outbreak of algae[16] and was difficult to predict such an outbreak. The GWI is believed to have taken the most appropriate measure suggested by the available knowledge to deal with the situation.

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14 At the time of the basic design study, it was believed that several years will be required till the supply of treated water covers the entire project area although the water meters were installed as planned, as some time would be required for the effect of meter installation on reducing the water demand to be felt.

15 As the raw water for the Queenstown WPT has a high level of nitrogen content and conductivity, it may provide good conditions for the propagation of algae.

16 A Japanese expert involved in the basic design told the present evaluator that he had not heard of an incident of an algae outbreak at a slow sand filter using groundwater as the raw water and that such an incident had not been assumed at the project planning stage.

At the time of the ex-post evaluation, the GWI is examining ways of reducing the quantity of pre-filtration chlorine injection or even eliminating this injection altogether by shading the facility by a structure, etc. to suppress the propagation of algae.

Slow sand filter bed at the No. 56 Village WPT (left) and Queenstown WTP (right)[17]

② Effects of the Soft Component

As part of the Project, the technical assistance relating to the operation and maintenance of a WTP was conducted as the soft component because the planned slow sand filter involved a technology which had not been previously used in Guyana. This technical assistance had the following objectives.

- Full understanding of the slow sand filtration method and the principle of iron removal using iron bacteria
- Development of the capability to operate new WTPs
- Development of the capability to collect necessary data for everyday maintenance
- Development of the capability to conduct adequate maintenance based on collected data
- Development of the capability to prepare an adequate maintenance plan, including sand scrapping work

These objectives appear to have been generally achieved based on the results of interviews with GWI engineers and those working at the WTPs, situation of storage and usage of manuals and operating status of the WTP facilities. It must be noted that the soft component of technology transfer did not involve a technology to control an outbreak of algae which

[17] A slow sand filter purifies water with a biological membrane formed on the surface of the filtering material (sand). At the No. 56 Village WTP, the iron bacteria method where iron bacteria is propagated on the sand surface is functioning well. At the Queenstown WTP, chlorine is injected to the raw water to suppress the propagation of algae. It is believed that this chlorine injection suppresses the formation of biological membranes at the same time. Differences in the raw water quality and filtering process are manifest in the colour of the water observed at these two WTPs.

subsequently became a problem at the Queenstown WTP because of the fact that such an outbreak at a slow sand filter bed is extremely rare, ant there was no way of predicting the necessity for such a technology. Moreover, as this technology transfer took place after the completion of the No. 56 Village WTP but before the construction of the Queenstown WTP, there was no opportunity to add the transfer of a suitable technology to deal with an outbreak of algae within the scope of the Project.[18]

< Beneficiaries Survey >

100 households were randomly selected from those located in Corriverton and face-to-face interviews using a questionnaire were conducted. The main findings are described below.

* Water tank installation rate: 94%
  Lifting pump installation rate: 22%
* Ratio of households using bottled water for drinking: 75%
* Problems of the GWI's water supply business as observed by its users (multiple replies permitted);
  Taste and smell: 47%; Colour: 40%; Water pressure: 24%
  Supply hours: 18%; Water charge: 16%; Maintenance: 6%
* Biggest problems among the above;
  Taste and smell: 29%; Colour: 18%; Water pressure: 10%
* Improved service after project implementation (ratio of households selecting the answer "Improved" from the multiple choices of "Improved", "No change" and "Worsened")
  Water pressure: 75%; Supply hours: 68%
  Maintenance (handling of water leakage, etc.): 56%
  Colour: 55%; Test and smell: 45%
* Meter installation rate: 94%
* Ratio of households that accept metered water charge system: 73%
* Ratio of households replying that they tried to reduce their water consumption after meter installation: 65%
* Ratio of households content with the current service: 90%
* Ratio of households replying that project implementation has resulted in an important positive change of their life: 48%
* Ratio of households replying that project implementation has resulted in a positive change of their life: 35%
* Ratio of households of which family members have experienced diarrhoea in the previous one year period (the basic design study produced a pre-project figure of 25%)
  - Among households using treated water: 13%
  - Among households using untreated water: 11%

[18] The No. 56 Village WTP was conducted under the Project for Water Supply in Corriverton (Phase I) while the Queenstown WTP was constructed under the Project for Water Supply in Corriverton (Phase II), completing the entire Project.

3.3 Impacts

3.3.1 Intended Impacts

The beneficiaries' survey found such positive impacts as a better taste of the water and less use of bleach due to the elimination of the reddish discolouration of clothing and dishes, both of which result from the removal of iron, in the areas receiving water supply from the No. 56 Village WTP. In contrast, such effects are not clearly established in the most of the service areas of the Queenstown WTP because of the low level of iron in the well water even before the Project.

Some 70% of the surveyed households in the project area reported an improved water pressure and supply hours (when the water actually reaches individual households). Because of this, availability of water has been enhanced, improving the convenience of life as water can be used whenever it is needed. Other positive impacts are a shorter water fetching time (in the past, people were sometimes forced to fetch water from a different area) and the non-requirement of a pump to compensate for the insufficient water pressure. All in all, almost half of the surveyed households replied that the recent improvement of the water supply service has had a positive impact on their life. Meanwhile, 90% of the surveyed households are content with the current service provided by the GWI.

The data gathered by the beneficiaries survey indicates that the number of incidents of diarrhoea has been slightly reduced compared to the pre-project figure. However, as a similar decline is recorded for areas receiving untreated water, there is no firm link between the declining number of incidents of diarrhoea and water treatment in the post-project period.

3.3.2 Other Impacts

The Project was implemented after the granting of an environmental permit which was issued by the Environmental Protection Agency in March, 2006. Prior to the actual work, the consultant prepared and implemented an environmental management plan, with which no specific problems have been reported. No special impacts on the natural environment are observed. The Project did not involve any resettlement of residents, and there were no special problems relating to land acquisition that were carried out based on relevant domestic regulations. There are no indirect impacts worthy of mentioning.

Based on the above, this Project has somewhat achieved its objectives, therefore its effectiveness is fair.

3.4 Efficiency (Rating: ①)

3.4.1 Project Outputs

The planned outputs of the Project are shown in Table 2. Although minor modifications were made at the implementation stage, these outputs were achieved almost as planned. The GWI has a high opinion of the quality of the construction work under the Project.

Table 2 Planned and Actual Outputs of the Project

Planned Outputs	Actual Outputs
(1) Water source wells: rehabilitation of three existing wells	
No. 57 Village well: output 45 kW	Output changed to 30 kW
Spring Garden well: output 37 kW	As planned
Queenstown well: output: 18.5 kW	As planned
(2) WTP: construction of two new WTPs (with a slow sand filter)	
• No. 56 Village WTP Treatment capacity: 3,800 m^3/day	As planned
• Queenstown WTP Treatment capacity: 5,500 m^3/day	As planned
(3) Laying of conducting pipelines: 5,230 m	Partial change of the planned route (5,330 m)
(4) Laying of distribution main pipelines: 15,471 m	Partial change of the planned route (14,990 m)
(5) Procurement of water meters: 8,400 meters	As planned
(6) Soft component: transfer of technology relating to the operation and maintenance of a slow sand filter bed	As planned

Sources: Basic Design Study Report and Project Completion Report

The modifications made at the implementation stage are explained below. All of them were necessary and appropriate.

- A pumping power of 45 kW at the No. 57 Village well as originally planned. At the detailed design stage, this pumping power in the basic design was found to be excessive in the light of the treatment capacity of the WTP and was accordingly reduced to 30 kW.

- The planned route for the conduction pipeline from the No. 57 Village well would run along a national road. Because of the completion of the rehabilitation work for this road, the Ministry of Public Works declined to approve the plan. Accordingly, the route was changed to run along a road in a residential area. In addition to a lower cost, this change made it easier for the work to be conducted because of a lower traffic volume.

- In the Phase I Project, it took longer than expected to lay the conducting pipelines along trunk roads while minimising any adverse impacts on traffic and commercial activities along the routes. To prevent a repetition of this problem, the pipeline routes in the Phase II Project avoided trunk roads, causing an increase of the total length of conducting pipelines by 100 m. Meanwhile, the construction cost was lowered because of the parallel laying of conducting and distribution main pipelines on the same routes.

- In the course of the Phase II Project, it was found that a pipeline, which connects main distribution pipelines on both sides of a road, was missing in some places despite the contrary assumption at the time of planning. Consequently, a connecting pipeline was additionally introduced to ensure equal water distribution on both sides of a road.

- The lifting pipe at the No. 57 Village well in the Phase I Project was a zinc-plated steel pipe. Because the subsequent more-than-expected corrosion of this pipe that caused water leakage, in response to a request made by the GWI, stainless steel pipes were used for all of the lifting pipes installed in the Phase II Project.[19]

3.4.2 Project Inputs

3.4.2.1 Project Cost

The actual project cost of ¥1,516 million was slightly higher (113%) of the planned cost. The reasons for this are explained in 3.4.2.2 Project Period.

Table 3 Planned and Actual Project Costs

(Unit: ¥ million)

Planned	Actual
Total project cost: 1,346 - Japanese portion: 1,329 - Guyana portion: 17	Total project cost: 1,515.5 - Japanese portion: 1,487.2 Phase I Stage 1: 647.2 Phase I Stage 2: 31.0 Phase II: 809.0 - Guyana portion: 28.3

Sources: Basic Design Study Report, Project Completion Report and GWI

19 The corroded pipe installed in the Phase I Project was replaced at the expense of the contractor. During this replacement work, pumping equipment accidentally fell to the bottom of the well. It took nearly a year to recover this equipment. The pump was repaired and the motor was replaced to restore pumping operation at this well.

3.4.2.2 Project Period

The Project was originally planned to be completed in March, 2009 by taking up 32 months to complete from the signing of the E/N in July. In reality, the completion was significantly delayed to September, 2010, taking 50.3 months (157% of the original plan).

Stage 1 of the Project for Water Supply in Corriverton (Phase 1) was completed in March, 2008, which was one month earlier than planned. However, for the stage 2 of the phase 1 project, the bidding ended in failure. The reason of the failure in the bidding is related to the increased prices of materials and equipment influenced by a price hike of crude oil. A company made a bid with the 27 % higher price than the bid ceiling and the negotiation of reducing the price was rejected. Since rebidding was impossible due to the rules of the grant aid scheme at the time and the remaining period mentioned in E/N was limited, only the detailed design work and soft component were conducted under the stage 2 and completed in April 2008.

For the remaining plant construction, an implementation review study, which was required to revise the existing design and quantity survey results, was subsequently conducted and the actual construction work started in the following year as the Project for Water Supply in Corriverton (Phase II). As a result, the overall project completion was delayed by 18 months and the project cost exceeded the planned cost by approximately 10%.

The project cost slightly exceeded the planned cost while the project period significantly exceeded the planned period. Therefore, the efficiency of the Project is low.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspect of Operation and Maintenance

The operation and maintenance of the facilities constructed under the Project has been conducted by Division 5 of the GWI as planned at the time of the ex-ante evaluation. This No. 5 District Office has 52 staff members and the facilities in the project area are handled by the No. 83 Area Section (seventeen staff members).

At each WTP, four operators work for 24 hours on three shifts which last for eight hours each. These operators are responsible for the operation, inspection and maintenance of the facilities as well as testing of the water quality. Sand scrapping at the slow sand filter bed which must be regularly conducted is entrusted to an external contractor. As of March, 2014, three water source wells to supply raw water to the WTPs and three wells to supply untreated water are in operation. The GWI plans to reduce the number of wells supplying untreated water by one after the successful expansion of the area receiving treated water. The operation and maintenance of wells is conducted by a mobile team of the Section 083 of Division 5. As the current operation and maintenance system and the assignment of operators are almost as assumed at the time of the basic design, there are no specific problems worth mentioning

Division 5 has a contract with four private companies for meter installation and leakage repair. When water leakage is reported by a resident, etc. and is visually confirmed by a patrolling Division 5 staff member, one of these contractors and the maintenance section of Division 5 conduct the necessary repair. The repair of a water main pipeline is mostly completed within one day while minor repair work is done within three days. In recent years, the GWI has purchased acoustic leak detection devices. However, these are not yet used in the project area as priority is currently given to repairing reported and visually confirmed leakages. According to the beneficiaries' survey results, the leakage repair performance of the GWI has considerably improved recently and its response is now very swift. In short, the leakage monitoring and repair performance of the GWI is generally good, indicating that there was improvement in the performance from the time of the ex-ante evaluation.

3.5.2 Technical Aspect of Operation and Maintenance

As a result of technology transfer as the soft component of the project, the GWI has now mastered the basic operation and maintenance skills for the new slow sand filter system, including those for the planning and implementation of the regularly required sand scrapping. Although some of the operators who participated in the skill training under the soft component have already left the GWI, the relevant information and skills have been inherited within the GWI. There appear to be no special technical issues faced by the GWI in regard to the operation and maintenance of the wells and water distribution network.

The GWI has been making efforts to control the algae at the Queenstown WTP, including the gathering of information and research on the slow sand filter system. However, there are no experts on this issue in Guyana and the GWI cannot obtain proper advice. Against this background, the GWI has employed an alternative means (pre-filtration chlorine injection) to achieve a water quality similar to that at the No. 56 Village WTP and that it is independently examining a way of controlling algae without pre-filtration chlorine injection by means of blocking sunlight. These facts are positive proof of the technical capability of the GWI.

3.5.3 Financial Aspect of Operation and Maintenance

At the two new WTPs, there has been sufficient funding to meet the basic operation and maintenance expenses, including the personnel cost, electricity cost and cost of chemicals. No instance of insufficient budgetary funding impeding the operation and maintenance has been observed although there appears to be a shortage of reagents for water quality testing from time to time and this test is not necessarily conducted on certain items every day.

When the financial balances for the two new WTPs is estimated based on information provided by the GWI, the operational cost has increased by 1.7 times since the time of the ex-ante evaluation due to an increase of the personnel, electrical, chemical and repair costs, suggesting a slight deficit in the balance at present.[20]

The GWI has been suffering from a chronic deficit of the operating balance, necessitating a continual government subsidy.[21] According to the GWI, the principal reasons for such a deficit are the low level of the water tariff[22], low water charge collection rate and low water meter installation rate. Table 4 shows the operating balance of the GWI since 2010. While inaccurate water meter readings used to falsely boost the operating income[23], this situation has been gradually addressed since 2010. As a result, the operating income has been declining since 2010. In 2011, as the outstanding accounts payable were paid immediately, the operating balance for the year was significantly worse.

Table 4 Operating Balance of the GWI

(Unit: million GYD)

	2010	2011	2012
Revenue from water charge	3,971	3,374	3,182
Other revenue (subsidy, etc.)	2,148	4,236	3,208
Expenditure	6,475	9,737	7,033
Balance	-356	-2,127	-643

Source: GWI

20 In 2012, the operation and maintenance cost, excluding the depreciation cost of the water supply system, including the WTPs, was approximately 108 million GYD which was 1.7 times higher than the estimated cost (65 million GYD) in the basic design. Meanwhile, the revenue from the water charge for the above system is estimated to be approximately 99 million GYD based on the production volume (4,881,000 m^3), the ratio of non-revenue earning water (52%), unit water charge (68 GYD/m^3) and water charge collection rate (national average of 62%). This revenue is slightly less than the operation and maintenance cost.

21 This subsidy is provided by the Ministry of Finance in correspondence with the amount of debt of the GWI.

22 The GWI's water tariff has remained unchanged since 2008.

23 For many years, the GWI had a practice of overcharging customers based on an inflated water consumption level with a view to making a refund if a user made a complaint.

The GWI is aiming at putting its operating balance in the black in 2016 by means of installing water meters (target installation rate in 2015 of 95%) and reducing leakage. In 2013, the GWI established the Non-Revenue Water Reduction Unit as part of its commitment to reducing the quantity of non-revenue earning water. An increase of the water tariff by approximately 30% has been approved by the government and the new tariff is expected to come into force by the end of 2014.

In summary, although there are no specific financial problems impeding the operation and maintenance of the facilities constructed under the Project, the GWI is required to continue to make efforts to put its operating balance in the black from the long-term point of view.

3.5.4 Current Status of Operation and Maintenance

The field survey did not find any major functional or physical problems with the facilities. The operation of the new facilities is practically as planned except for the experimental pre-filtration chlorine injection at the Queenstown WTP to control outbreaks of algae and a lack of sand washing and re-use after sand scrapping work at the two new WTPs.[24] The spare parts procured under the Project are stored at the WTPs and are used when required. Both the WTP operators and well operators (mobile operator) manage their respective facilities in accordance with the operating rules set forth by the GWI and maintain operation records.

Based on the above, the operation and maintenance system of the facilities constructed under the Project and its financial aspect are both adequate. The GWI has the technical capability to ensure the quality of water by employing an alternative means of controlling outbreaks of algae at a slow sand filter bed. In short, none of the institutional, technical or financial aspects of the operation and maintenance pose any problems and the sustainability of the project effects is high. However, the GWI must make continual efforts to put its operating balance into the black from the long-term point of view.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Project was implemented to improve the water supply service in Corriverton in Guyana by means of rehabilitating the existing water source wells, constructing new WTPs, laying

[24] It has been necessary to conduct sand turning more frequently than assumed in the basic design. Because of the large amount of labour required to wash the sand, it has been judged that the purchase of new sand is more economical that the re-use of washed sand.

conducting and distribution main pipelines and procuring water meters. The supply of safe water has always been a priority issue in the national plan of Guyana. The expansion of areas receiving treated water is still a pressing task in coastal regions and the need for the Project is very strong. As the Project was in line with Japan's ODA policy, the overall relevance of the Project was high. At the WTPs constructed under the Project, iron in the raw water is now removed. However, coliforms are sometimes detected in the treated water, indicating that the safety of the water or capacity for water testing is in question. Partly because of the slower-than-planned progress of the reduction of the water demand to correspond to the treatment capacity of the WTPs, the size of the population receiving treated water at the time of this ex-post evaluation is some 60% of the planned size. Meanwhile, the installation of water meters and progress of leakage control have increased the water pressure throughout the project area, improving the convenience of water use along with an improved water quality due to the removal of iron from the raw water. The Project has somewhat achieved its objectives and its effectiveness and impact is fair. Because of problems with the tender due to the unexpectedly high price hike of construction materials and equipment, the completion of the Project was delayed by one and a half years from the originally planned completion date. As the project cost also exceeded the original plan, the efficiency of the Project is low. The institutional and financial aspects of the operation and maintenance of the facilities constructed under the Project are adequate. Although an outbreak of algae occurred at one of the WTPs with slow sand filter bed, technical capability to ensure the required quality of the treated water by means of employment an alternative means of algae control is available. As such, the sustainability of the Project effect is high. In light of the above, this Project is evaluated to be partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations for the Executing Agency

- It is necessary for the GWI to further reduce the water leakage and to advance the metered water charge collection in Corriverton to reduce the local water demand while making efforts to expand the areas receiving treated water in the project area.

- It is necessary for the GWI to conduct a technical examination with the assistance of an external expert(s) of the viability of controlling algae at the Queenstown WTP using a more appropriate method than the current pre-filtration chlorine injection.

- It is necessary for the GWI to strengthen its own water quality testing system and capability to check for any contamination of the raw water as well as the treated water (for the detection of coliforms) and its causes. Whenever contamination is discovered, the GWI must introduce appropriate control measures.

4.2.2 Recommendations for the JICA

Pre-filtration chlorine injection, the employment of which to the slow sand filtering process is unusual, is conducted at the Queenstown WTP to control outbreaks of algae, pushing up the operating cost. It is desirable for the JICA to urgently examine and implement possible technology transfer designed to control algae at slow sand filter by means of applying such means as the existing Training and Dialogue Programs and dispatch of short-term expert to the GWI.

As the prices of the construction materials for the Project had soared by the time of the detailed design and tender for Stage 2 of Phase I from the earlier assumed prices in the basic design, the tender was unsuccessful, making it necessary to revise the design and estimated project cost. In turn, this significantly delayed the actual implementation of the project-related work. To avoid the recurrence of such a situation, it is desirable for the JICA to modify the system for project cost estimation so that a revised system is capable of reflecting price escalation.

4.3 Lessons Learned

Under the Project, the transfer of technology relating to the slow sand filtration process was conducted after the completion of the first WTP. At the second WPT, there was an unexpected outbreak of algae which the GWI struggled to control, eventually adopting the expensive alternative of pre-filtration chlorine injection. If there had been an opportunity for technology transfer after the commissioning of the second WTP, a quick and adequate response could have been made within the scope of the Project, such as the introduction of new technology transfer to deal with this outbreak of algae. If sufficient attention had been paid to the different quality of the raw water for these two new WTPs, it could have been possible to set an appropriate timing for technology transfer by establishing a window for technology transfer for each WTP based on the assumption that the actual operation at each WPT may experience different operating conditions. It is, therefore, important to carefully plan the scope and timing of technology transfer when the slow sand filtration process is introduced in a country with no previous experience of this process while exploring all different possibilities that could affect the biological phase of a filter bed, including an outbreak of algae, because of the different quality of the raw water.