No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR WATER SUPPLY
IN
CORRIVERTON
CO-OPERATIVE REPUBLIC OF GUYANA

JUNE 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

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JR
06-105

PREFACE

In response to a request from the Government of the Co-operative Republic of Guyana, the Government of Japan decided to conduct a basic design study on the Project for Water Supply in Corriverton and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Guyana a study team from November 13 to December 23, 2005.

The team held discussions with the officials concerned of the Government of the Co-operative Republic of Guyana, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Guyana in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Co-operative Republic of Guyana for their close cooperation extended to the teams.

June 2006

Masafumi Kuroki
Vice President
Japan International Cooperation Agency

June 2006

LETTER OF TRANSMITTAL

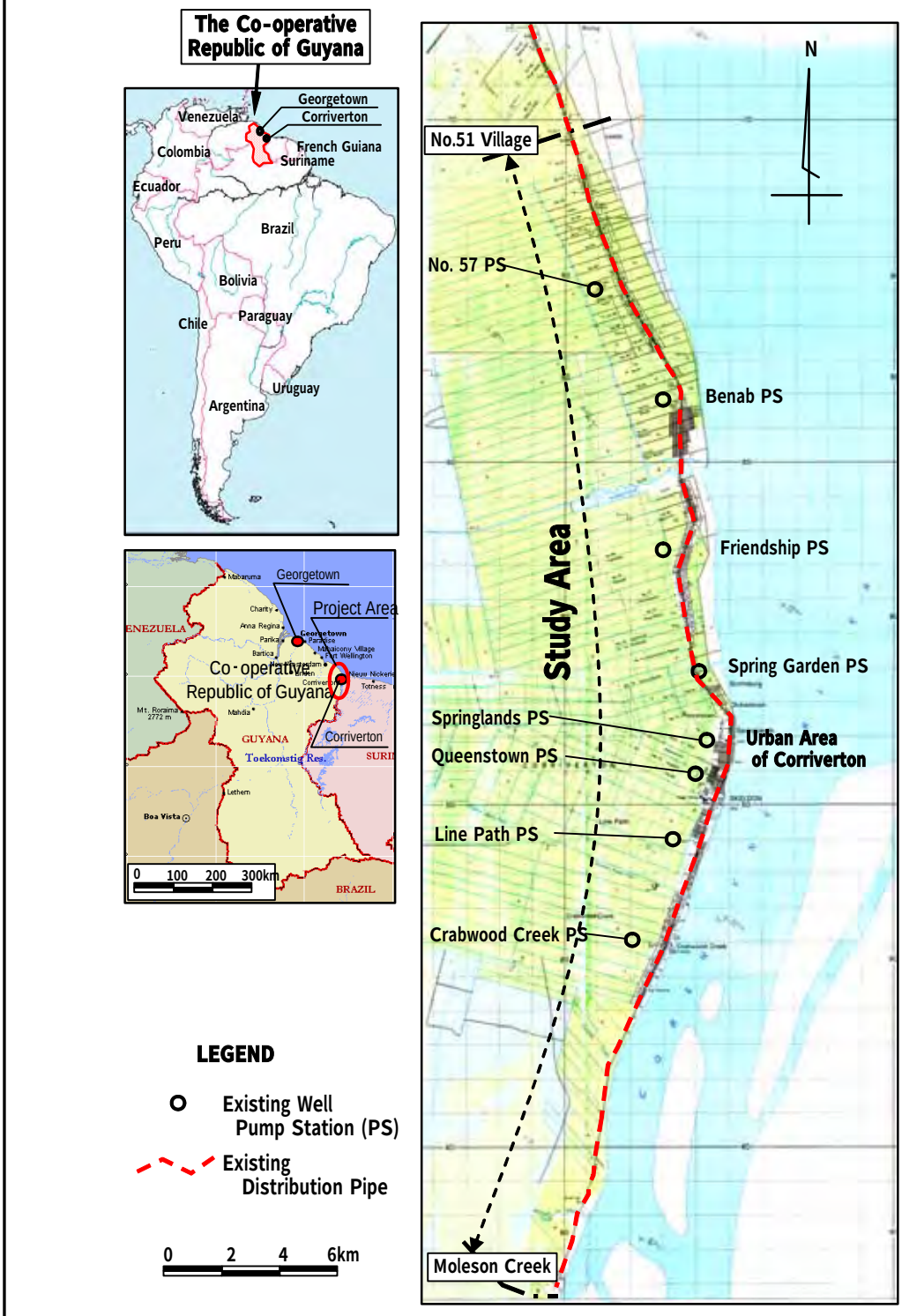
We are pleased to submit to you the basic design study report on the Project for Water Supply in Corriverton in the Co-operative Republic of Guyana.

This study was conducted by Tokyo Engineering Consultants Co., Ltd., under a contract to JICA, during the period from November 2005 to June 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Guyana and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Akira Takechi
Project Manager,
Basic Design Study Team on
The Project for Water Supply in Corriverton,
The Co-operative Republic of Guyana
Tokyo Engineering Consultants Co., Ltd.



PROJECT LOCATION MAP

Photographs

Suburb area of the Project area. The existing distribution trunks run along both road shoulders.

Close set area in the Project area. The existing distribution trunks run along both road shoulders.

Existing No.57Village pumping station.
This well is a water source of the No.56 Village WTP.

Existing Spring Garden pumping station.
This well is a water source of the Queenstown WTP.

Site for No.56Village WTP
Left side: Existing ditch.. Right side: Cricket ground. Back: WTP Site. There are several residences left of the ditch.

Site for Queenstown WTP.
Presently sugar cane field surrounded by ditches. Access road will be construct by infilling the ditch. No house around.

River crossing of the existing distribution trunk by bridge suspension

River crossing by wooden pile. Locally available hard wooden pile is resistant to corrosion. River crossing by wooden pile is common works in GWI.

Low pressure water supply. Residents of this house can receive water only from this hydrant set at ground level.

Exposed water meter. Service pipe is exposed and there is no cover of meter.

Supplied water coloured by iron

Leakage form distribution pipe. Possible damage by being exposed.

PERSPECTIVE OF QUEENSTOWN WTP

Abbreviations

CARICOM	Caribbean Community and Common Market
CDB	Caribbean Development Bank
CHPA	Central Housing and Planning Authority
DFID	Department for International Development
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Exchange of Notes
EPA	Environmental Protection Agency
EU	European Union
GDP	Gross Domestic Production
GPL	Guyana Power and Light Co.
GT&T	Guyana Telephone and Telegraph Company Limited
GUYSCO	Guyana Sugar Corporation
GWI	Guyana Water Incorporated
GYD	Gyanese Dollar
HIPCS	Heavily Indebted Poor Countries
IDA	International Development Association
IDB	Inter-American Development Bank
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
MOA	Ministry of Agriculture
MOF	Ministry of Finance
MOFTIC	Ministry of Foreign Trade and International Cooperation
MOHW	Ministry of Housing and Water
NDC	Neighourhood Democratic Council
NDS	National Development Strategy
PRSP	Poverty Reduction Strategy Paper
PS	Pumping Station
PUC	Public Utilities Commission
PVC	Polyvinyl Chloride
USAID	U.S. Agency for International Development
USD	United States Dollar
WB	World Bank

SUMMARY

The Co-operative Republic of Guyana (hereinafter referred to as Guyana) situates in the northeast of the South America Continent facing to the Atlantic Ocean with population of 751 thousands (Census 2002) and area of 215 thousands km^2. Due to the small size of population, the industrial production has not very developed and the national economy mainly depends on the agricultural productions, such as rice and sugar cane. Gross national production per capita in 2004 is USD 868.60.

The Government of Guyana adopted in 2001 the National Development Strategy 2001 – 2010 (NDS) and Poverty Reduction Strategy Paper (PRSP) as a national development policy. NDS and PRSP highlight the importance of the development of the social sector as means of the poverty reduction and the fulfillment of the basin human needs and further stress the importance of supply of safe water among the sector.

For the water sector, PRSP points out the poor operation and maintenance of the facilities, low quality of the treated water and insufficient access to the water service as major issues and requires to address the issues by i) supplying safe water to 95% of the population, ii) establishing a consolidated water supply service company, iii) strengthening water supply service in the coastal areas by promoting water treatment and iv) to implement comprehensive rehabilitation and operation and maintenance plans.

Guyana Water Incorporation (GWI) was established in 2002 to consolidate country's water supply services as one of results of addressing the issues pointed out by PRSP, since then GWI has been operating water supply service under the license given by Ministry of Housing and Water (MOHW). Water supply coverage is estimated to reach at 83% in a nation wide average, it has however problems in quality of the supplied water, such as risk of the bacterial contamination and unacceptability due to unpleasant taste and odor and coloring by high concentration iron. It also has problems in water supply quantity as it can not maintain 24 hour operation of water lift of pumps of the water source wells due to high electricity cost and water can not distributed without lift pumps operation which is required to pump water to entire water supply area where no gravity flow is applied because of flat land. In addition, since installation of water meters remains low rate (25% in national average) and water quantity cannot be measured, it causes wastage of water by users and difficulty in estimating water leakage.

To address to the above issues, the Government of Guyana requested the Government of Japan a grant aid assistance in August 2003 to implement the following projects:

- Rehabilitation of 4 water source wells
- Installation of transmission Mains with a total length of 33 km.
- Installation of conduction lines with a total length of 7 km.
- Construction of 2 Water Treatment Plants.

- Installation of distribution mains with a total length of 35 km.
- Construction of 2 ground water reservoirs with each volume of 2000m^3.
- Construction of 2 elevated water tank with each volume of 400m^3.
- Installation of 9800 number of Water Meters.

The Government of Japan decided to implement a basic design study for the requested project and Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team to Guyana from 13 November to 23 December 2005. The Team held discussions with the officials concerned of the Government of Guyana and conducted a field survey at the study area.. The Team prepared Draft Report of the Basic Design Study based on results of the basic design study and explained it to and discussed on it with the Guyanese side from 18 to 27 March 2006. Based on the discussion this report was finalized. Summary of the report is as follows:

The Project will construct water supply system to supply safe water continuously for 24 hours with sufficient water pressure and procure water meters to contribute to the improvement of financial conditions of the water supply operation by assisting water leakage control programme.

Basic policies of planning are as follows:

- Average daily design water supply rate was set out 6,600m^3/day based on the population in 2015 of 35,598 estimated from the 2002 census population and the per capita water consumption rate of GWI's design standards, 180 l/capita/day. Water quality target was set out iron less than 0.3 mg/l, turbidity less than 5 NTU, pH between 6.5 and 8.5, no detection of coliform bacteria and residual chlorine between 0.5 and 0.6 mg/l/

- As the existence of iron bacteria in well water, slow sand filtration with iron removal by iron bacteria is adopted as a water treatment method.

- No.56 Village site and Queenstown site are selected as the water treatment site by considering easiness of land acquisition and required total pipe length. Each plant has capacity of 3,800 m^3/day and 5,500 m^3/day, respectively and a water reservoir and an elevated water tank are constructed in each plant site.

- No.57 Village well for No.56 Village WTP and Spring Garden well and Queenstown well for Queenstown WTP are selected as water source wells for WTPs.

- Capacity of water reservoir is determined by 8 hour equivalent volume of daily maximum water supply rate to cover a peak flow rate.

- Height of the elevated water tank is set out less than 25 m considering soft ground condition.

- To avoid renewal and expansion of the existing distribution mains, treated water from each WTP is supplied at the two connection points so that the water pressure is maintained minimum 0.7kg/cm^2 throughout the distribution network by the elevated tank with elevation of 25 m.

- 8,400 water meters are procured to install them all the customers in 2015.

- GWI will be provided with operational theory and skills of the slow sand filtration through the Soft Component programme of the Project.

Outlines of the Project facilities are as follows:

Outlines of the Facilities

Facilities	Component
Water Source Well (Rehabilitation)	• No.57 Village well: Replacement of lift pump (1 no)、Emergency generator (1) • Spring Garden well: Replacement of lift pump (1 no)、Emergency generator (1) • Queenstown well: Replacement of lift pump (1 no)
WTPs	• No.56 Village WTP：Slow sand filter, Water reservoir, Elevated tank, Distribution pump, Chlorine disinfecter, Emergency generator、Generator building and Office/store building • Queenstown WTP：Slow sand filter, Water reservoir, Elevated tank, Distribution pump, Chlorine disinfecter, Emergency generator、Generator building and Office/store building
Conduction lines	• No. 57Village well to No.56 Village WTP: 98.0m • Spring Garden Well to Queenstown WTP: 4,332.0m • Queenstown well to Queenstown WTP: 100.0m
Distribution Mains	• No.56 WTP to No.47 Village connection point: 798.0m • No.56 WTP to No.67Village connection point: 7,038.0m • Queenstown WTP to Springlands connection point: 1,805.0m • Queenstown WTP to Crabwood Creek connection point: 5,830.0m

Number and specifications of water meter procured are as follows:

Outlines of material Procured

Name	Specifications	Number
Water Meter	Turbine type flow volume meter. To measure water consumption rate of each customer by installing on the service pipe.	8,400

Technology transfer for the slow sand fitter operation will be provided to the plant operators through the Soft Component programme consisting of seminar, preparation of operation manuals and on-the-job training.

Following direct benefits are expected by the implementation of the Project:

- Safe water with no coli form bacteria, and
- acceptable with iron less than 0.3 mg/l
- is supplied 24 hour continuously
- with sufficient (0.7kg/cm^2) pressure.

Expected indirect benefits are:

- Increase of water revenue by installing water meter to all the customers, ad
- Reduction of disease risk by safe water

Total project cost required for the execution of project by Japanese Grant Aid is estimated to be about 1,363 million JPY (about 1,346 million JPY by Japanese side and 17 million JPY by Guyanese side) based on responsibility of Government of Japan and Guyana. The breakdown of the project cost of Japanese side is shown in the following table.

Cost Covered by Japanese Side

Expense Item			Approximate Cost (million Japanese Yen)		
Facility	Rehabilitation of Existing Wells	Emergency Generators, Well Pumps	54.8	1,134.5	1,208.5
	Construction of Water Treatment Plants	Slow Sand Filters, Storage Reservoirs, Elevated Tanks, Chlorinators, Lift Pumps	875.2		
	Installation of Conduction and Distribution Main Pipe Lines	Excavation, Pipe Laying, Back Filling, Repavement	204.5		
Equipment and Material	Water Meters	Water Meters, Accessories, Meter Boxes	74.0	74.0	
Detail Design・Supervision of Construction					137.3
Approximate Project Costs					1,345.8

Total project cost of Japanese side: 1,3435.8 ,Million Yen

The cost estimate is provisional and will be further examined by the Government of Japan for the approval of the Grant.

The Project is implemented in two phases. The work periods of the first and second phases are 20 months and a total work period is 32 month including 8 months of overlapping period.

The Project is judged to be appropriate as a Japanese grant aid project from following points:

- The project will benefit all the residents in Corriverton area and the benefit population is estimated at 32,000 in 2006 and 36,600 in 2015. The Project ensures safety and acceptability of drinking water and 24 hour continuous water supply with sufficient water pressure, contributing to the improvement of the people's living environment.
- Water supply facilities constructed by the Project will be operated and maintained by GWI which has been operating the same type of facilities, GWI, therefore, is not expected to have particular difficulty in their operation and maintenance
- It can be expected that the water meters procured will be installed as scheduled and maintained properly since GWI has already established plans for the installation, repairing and calibrating of the water meters.
- The Project will be implemented as one of measures to achieve the improvement of the service quality which was specified as one of conditions of the GWI's Operation License.
- No adverse environmental effects are expected.

However, in order the Project to achieve the expected effects it is necessary to reduce the leakage loss by installing water meters procured in the Project to all the users in the earlier stage, applying meter rate water tariff, accelerating the on-going leakage control programme and establishing leakage monitoring and repairing system.

CO-OPERATIVE REPUBLIC OF GUYANA
THE PROJECT FOR WATER SUPPLY IN CORRIVERTON

BASIC DESIGN STUDY REPORT

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Exchange Rates

1 USD = 113.53JPY
1 GYD = 0.58JPY

CHAPTER 1 BACKGROUND OF THE PROJECT

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Water supply services in the Co-operative Republic of Guyana (hereinafter referred to as Guyana) is operated by Guyana Water Incorporated (GWI).

In Guyana, as most of population is concentrated along the coastal line, 90% of water sources rely on groundwater from rich aquifers of the coastal plain while only 10% rely on the surface water. Development of the water supply system was rather easy by digging wells in populated areas and laying down the distribution pipes along the trunk roads since inhabited areas expand along the trunk roads within a few kilo meter width. Water supply coverage has already reached to 83% in national average and nearly 90% in the coastal areas. The distribution trunk lines link throughout the sections divided by large rivers.

Water supply facilities development by such rich groundwater in flat land, while it has accelerated the coverage, causes water supply problems such as water supply failure by electricity failures, water shortage during peak flow periods and low water pressure in the network ends due to the direct water distribution without storage reservoirs and elevated tanks. Moreover, it has a difficulty in 24 hour continuous service because most of the water source wells are operated for only 12 hours due to the high electric power charge. It also has problems in operation and maintenance of the wells and distribution management because water is supplied from many wells to the distribution lines.

As for the water quality of the supplied water, the present system has erosion and iron separation problems due to high iron and carbon dioxide concentrations in the groundwater. A few systems have treatment plants with iron and carbon dioxide removal, however, as most of systems do not have any treatment system, users are suffering from unpleasant taste and odor and coloring by iron. Risk of the bacterial contamination is low because of deep aquifer water, in general. However, since most of the systems do not employ the disinfection, coliform bacteria are detected from tap water occasionally and safety of water is not maintained.

Water leakage are supposed to be high and due to low installation of water meters non revenue water cannot be analyzed, causing difficulty in the operation management.

As such, problems to be addressed Guyana water supply services are improvement of the service quality by supplying abundant safe water for 24 hour continuously with enough pressure and of the management by reducing non revenue water rather than increase of the water supply amount and water supply population by augmentation of the water supply facilities.

To improve such problems in the water supply services, the Government of Guyana requested the Government of Japan for the grant aid for the following provisions in August 2003.

- Rehabilitation of 4 water source wells
- Installation of transmission Mains with a total length of 33 km.
- Installation of conduction lines with a total length of 7 km.
- Construction of 2 Water Treatment Plants.
- Installation of distribution mains with a total length of 35 km.

- Construction of 2 ground water reservoirs with each volume of 2000m^3.
- Construction of 2 elevated water tank with each volume of 400m^3.
- Installation of 9800 number of Water Meters.

The requests aim to supply safe water continuously by centralizing scattered wells into two water treatment plants, securing peak flow by storage reservoirs, maintaining proper water pressure by elevated tanks and promoting the water meter coverage. Therefore, the project is judged to contribute to the improvement of the water supply service quality.

Among the requests above, “Installation of transmission Mains with a total length of 33 km.” was deleted since its necessity was confirmed to be low and “Installation of 9800 number of Water Meters.” was changed to “Procurement of 9800 number of Water Meters.” since it was confirmed as a result of the Preliminary Study that GWI would install them.

CHAPTER 2 CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Targets

The National Development Strategy (NDS) has been adopted as a national plan from 2001 to 2010 and Poverty Reduction Strategy Paper (PRSP) has been prepared as a medium term plan to address the poverty reduction which is one of targets of NDS.

PRSP identified poor operation and maintenance of the water supply facilities, low quality of the supplied water and insufficient access to clean water as major problems of the water sector and proposed i) safe water supply to 95% of the population, ii) establishment of a Guyana water company, iii) promotion of water treatment in the coastal areas and iv) enhancement of facilities rehabilitation and operation and maintenance activities as a medium term strategy.

GWI was established in 2002 as a part of the strategy, aiming the consolidated management of the water supply operation. GWI operates its water supply and sewerage services under the license (License to supply water and sewerage services and advisory services for public purposes granted to Guyana Water Inc. under section 90 of the Water and Sewerage Act 2002, effective from 13 November 2003 for 10 years). The license obliges GWI to achieve specific service quality and performance standards.

The project targets the improvement of quality of water supply services in Division 5 which is one of coastal areas being emphasized in the medium term strategy.

2.1.2 Concepts of Project

The project aims to improve water supply conditions in Corriverton area by developing water supply facilities such as water treatment plants, water reservoirs and elevated tanks and by procuring water meters. Among the service standards required in the Operation License of GWI, since the coverage has almost reached to 100% in the project area, the project will contribute to the improvement of the service quality by achieving water quality, continuous water supply and meter coverage targets.

On the other hand, non revenue ratio of GWI is reportedly over 50%, leakage and wastage control, therefore, is a precondition of the achievement of the project purpose. GWI is carrying out its own leakage control program supported by DFID fund. The project could also support the program from equipment and facility aspects by providing water meters and divided water distribution districts equipped with bulk water meter.

Concepts of the project are summarized in the project design matrix as shown in Table 2.1.

Table 2.1 Project Design Matrix

Objectives/Activities	Objectively verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal ✓ Quality of water supply services is improved resulting in the improvement of living conditions of the project area.	✓ Customer's satisfaction level ✓ Nonpayment rates	✓ Customer satisfaction survey ✓ GWI sales report	✓ No rapid economical and political changes occur.
Project Purpose ✓ Safe water is supplied to the resident of the project area 24 hour continuously.	✓ Faecal coliform number ✓ Iron contents ✓ Water supply duration ✓ Water supply pressure	✓ Water quality monitoring ✓ Operation records	✓ Urban infrastructures other than water supply remain current level.
Results ✓ Water supply facilities in Corriverton is improved. ✓ Water meters are installed.	✓ Total length of conduction and distribution main pipe lines ✓ Capacity of water treatment plant ✓ Number of water meters installed.	✓ Construction records. ✓ Leakage survey record ✓ O & M records ✓ Record of water meter installation.	✓ DFID's supports to leakage control continue and effects of the leakage control become significant.
Activities ✓ Rehabilitation of water source wells. ✓ Installation of conduction pipe line. ✓ Construction of water treatment plant (slow sand filters, clear water reservoir, disinfection and elevated tanks) ✓ Installation of distribution main pipe line. ✓ Installation of water meter.	Inputs <Japanese side > ✓ Fund for well rehabilitation, WTP construction, conduction and distribution pipeline installation. ✓ Fund for water meter procurement. ✓ Dispatching design and construction engineers.	<Guyanese side> ✓ Construction and O & M cost ✓ Assigning design and construction engineers ✓ Execution of leakage control ✓ Early installation of water meters procured and application of metered rate tariff.	Required budget is allocated to the project. Preconditions: Presentation of guarantee of the implementation of the leakage control program supported by DFID which results in installation of water meters to be procured in the project and of the application of metered rate tariff.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Policy

Requests of the Government of Guyana consisted of following contents:

- ✓ Rehabilitation or construction of well pumps.
- ✓ Construction of conduction pipeline.
- ✓ Construction of water treatment plant (WTP) for the iron removal and disinfection.
- ✓ Construction of 2 ground storage reservoirs and 2 elevated tanks, but quantity is subject to the results of the Basic Design Study (the Study).
- ✓ Reinstallation of the existing distribution trunk pipelines, if required as a result of the Study.
- ✓ Procurement of 9,800 water meters.

1) System Planning Policy

The request of the Project does not specify quantity and specifications of the facilities except the procurement of the water meters, but requests the provision of a system that enables continuous supply of safe water. Therefore, the Study started with the system planning according to the

following planning policies:

i) Target year is set at 2015. Design water demand is calculated based on the estimated population in 2015 and the per capita water demand.

ii) WHO water quality standards[1] shall be adopted as a water quality target since GWI's water quality standards follow them.

iii) GWI Design Parameter set the water quality standards of items related to the acceptability as follows:

Iron:	Less than 0.3mg/l
Turbidity:	Less than 5 NTU
pH:	6.5 to 8.5
Faecal Coliform:	0 CFU/100ml
Residual Chlorine:	0.2mg/l to 0.5mg/l

As it was confirmed that iron concentrations of all the well water exceeded the above standard and faecal coliform were often detected in various samples from wells and water taps by the results of water quality monitoring and the water quality survey of the Study[2], the Project shall construct water treatment plant(s) for the iron removal and disinfection.

iv) The existing WTPs employ rapid sand filtration after air oxidation as an iron removal method. However, they are not properly operated because of high operation costs, especially high chemical cost. Therefore, slow sand filtration with iron bacteria, which is expected to be of low construction cost and low operation and maintenance cost, shall be studied as an alternative iron removal method. The existence of iron bacteria in water is an essential factor to apply slow sand filtration with iron bacteria. It will be confirmed by the results of the iron bacteria test conducted in the Basic Design Study. It is concerned that GWI has little experience in the operation of the slow sand filtration, however, it will be overcome by providing operator training as a soft component of the Project.

v) Direct water transmission from the existing wells to the distribution networks without storage reservoirs and elevated tanks are considered to be major causes of shortage of water supply and low pressure in the networks. Therefore, the Project will construct ground storage reservoirs to average the peak flow and elevated tanks to maintain the pressure at minimum[3] 0.7kg/cm^2 in entire distribution networks. Although the elevated tanks are supposed to be constructed in the vicinity of the distribution network, they will be constructed in the WTP site due to the expected difficulty in land acquisition.

vi) WTP sites will be selected from seven candidate sites presented by GWI, considering size, difficulty in land acquisition and impacts to living conditions of neighbourhood.

vii) As it was confirmed that the existing wells have enough water production capacity to the

[1] WHO's Guidelines for drinking water quality, 3rd edition indicates guideline values for chemicals that may hazardous to human health at the level which occurs in potable water and indicates reference values for items related the acceptability aspects.
[2] For other water quality items, refer to3) Water Quality of (2) Overall Plan of 2.2.2 Basic Plan in this chapter.
[3] In the service standards targets which GWI is obliged to achieve in the Operation License, the required end pressure is relaxed to 0.5 kg/cm^2. However, presently GWI applies 0.7 kg/cm^2 in their Design Parameter which GWI took over from Guyana Water Authority and Georgetown Sewage and Water Commissioners.

design water demand, the Project will not construct new wells. Water source wells for the WTPs newly constructed will be selected from the existing wells considering the production capacity and distance to the WTP.

viii) Size and connection point of the distribution main pipe which sends water from the elevated tanks to the existing distribution network will be determined so that following conditions are satisfied.

- ✓ Not to replace the exiting distribution trunk pipe with larger ones.
- ✓ To keep height to elevated tanks less than 25m.
- ✓ To maintain the end pressure at minimum 0.7kg/m^2 in entire network.

ix) Number of water meter to be procured in the Project will be determined so as to install them in all the customers in 2015.

2) Policy for Leakage and Wastage Control

The Study revealed that the present water supply rate is 500 l/capita/day[4] and anticipated that water leakage during distribution and water wasting by customers would be major causes of the current water shortage and low pressure. The Study recommends and adopts 180 l/capita/day, which is GWI's Design Parameter, as a design unit consumption, which is estimated appropriate to meet the current domestic demands if water is properly used. However, it is concerned that severe water shortage as a result of the Project implemented could occur, if the present leakage problems are left as it is and customers' mind remain unchanged.

Therefore since the expected benefits of the Project can be seen only after water leakage and wastage are controlled substantially, it is a precondition of the project implementation that guarantee of the implementation of the leakage control program and installation of the water meters procured by the Project and consecutive application of the meter based tariff is presented. For the leakage control, GWI has launched its leakage control strategy[5]. GWI is required to review the water leakage strategy so that the leakage control in the Project area can proceed in accordance with the progress of the Project.

However, it would take some time until the effects become significant, even GWI starts the leakage control activities and the installation of the water meters during the Project implementation. If the supply rate is reduced to 180 l/capita/day immediately upon the completion of the Project, it could definitely cause water shortage problems in the Project area and may incur negative evaluation of the Project. In order to avoid such transitional problems, the Project will leave the wells not used for the water resource of WTP as it is so that they can supplement the water when the water shortage problems happen.

Since the daily average water supply rate, 180 l/capita/day, in the GWI's Design Parameter includes 25% of non-revenue water (refer to footnote 6), the leakage and wastage control is judged to be achieved when the leakage and wastage ratio become 25%.

[4] Calculated from GWI Operation Record (January to October 2006). A total of discharge of each pump recorded was divided by the estimated population (31,643, refer to Table 2.3) in the project area.

[5] GWI's Leakage Control Strategy 2004 intends to establish DMAs, and to organize leakage inspection team and leakage repair team in each Division. Some programs of the strategy have already started in Division 1 to 4. For Division 5, it will start after 2006.

3) Project Implementation Policy

The Project implementation will be divided into two phases due to the expected large work amount.

The work shall be divided into two so as each phase to give project benefits. For example, if the total system has two WTPs, each phase should construct one WTP and its related pipelines. This would enable to bring out the benefit of each phase.

(2) Design Policy

The basic design will be carried out based on the following policy.

1) Natural Conditions

- ✓ There are two rainy seasons in Guyana. The principal rainy season occurs around May and June and the secondary occurs from November to next March. In addition, as there is no distinct dry season, minor rainfall occurs during whole year. It is not avoidable to work during the rainy season therefore the foundation work, which is strongly affected by rainfall, shall be scheduled off the principal rainy season.
- ✓ All the construction sites of the Project are located on the alluvial plain with wet and dump, flat and soft ground conditions, which raise concern about sinking of structures. According to results of the soil survey conducted in the Study, the proposed facility sites are of +1.39m above equivalent mean sea level with high groundwater level. While soil layer from surface to 18 to 22m depth is soft silty clay with N value=0 of the standard penetration test, the deeper is very solid consolidated silty clay with N value = 30 - 50 of the standard penetration test.

  It is required to make the facilities with reduced load conditions as much as possible since depression is not avoidable. Also it is required to shallow the excavation depth because of high groundwater level.

2) Social Conditions

- ✓ The Project will construct WTP and install conduction pipes from the wells to WTP and distribution main pipes from WTP to the existing distribution trunk pipelines. Since conduction and distribution pipes are installed under the roadway, no land acquisition is required. For the WTP sites it would be possible to avoid land acquisition and resettlement issues by selecting the sites, which have been under the possession of the Ministry of Housing and Water and have no impact to surrounding areas.
- ✓ Project area spreads along the main road from New Amsterdam to Moleson Creek. Generally houses and farmlands are scattered along the road, but in the Corriverton urban area, about 3 km among total 36 km, small shops and offices continue along the street. In this area people use the road shoulders as parking space and business activities. Pipe installation in this area could interrupt their daily activities but it would be unavoidable because no alternative routes are available. To minimize the interruption, it is required to divide the work section into small size in which all the work such as excavation, pipe laying, back filling and repavement, can be completed within one day.

- ✓ Unscheduled power shut down is not unusual in the Project area due to shortage of power supply capacity of Guyana Power and Light (GPL). The current water supply services are available only for 12 hours in average a day. However, since the Project aims 24 hour continuous water supply services, it is required to install emergency generators in the wells and WTPs.
- ✓ Electricity power source for the WTP will be drew from high voltage over head cables with 13.8 kV. Due to deterioration of their generating facilities, GPL is difficult to supply electricity capacity more than 150 kVA. Therefore, the limit of electricity capacity shall be well considered in designing WTP.

3) Local Construction and Procurement Conditions

- ✓ The construction industry in Guyana is of small scale and of low capacity. Also numbers of skilled labours are limited. Facility design which requires high work precision may cause delay in work schedule. Therefore facility design shall incorporate locally popular methods as much as possible.
- ✓ Although domestic products of Guyana are very limited and most of construction materials and equipment are imported, the facility design shall aim to utilize domestic product as much as possible.

4) Capability of Executing Agency for O & M

- ✓ The purposes of the Project, supply of safe water for 24 hour continuously with enough pressure, can be achieved only when the effects of the leakage and wastage control is substantial.
- ✓ In case slow sand filtration with iron bacteria is adopted, training of operators by the soft component of the Project is required.
- ✓ Slow sand filtration will be discussed as an alternative water treatment method although this is new to GWI because of expected advantages in construction and operation maintenance costs. However, methods familiar to GWI shall be adopted as much as possible for other facilities and operations.
- ✓ Electricity costs is high in Guyana compared to other commodity prices and is a big burden to the water supply management. It is said that one of reasons of not continuous water supply services over the country is this high electricity cost. Therefore, the facility design shall consider the operation costs as well as the construction costs.

5) Grade of Facilities, Equipment and Materials

- ✓ The specifications of facilities and equipment of the Project shall follow those of the existing facilities in general.
- ✓ Operation and control system shall employ manual types unless harmless.
- ✓ Many leakages were found around the water meters. Therefore, to enable proper fixing, some accessories will be included in the procurement. Also meter box will be included.

6) Construction Plan

- ✓ The project implementation will be divided into two phases. One WTP system (plant and pipelines) shall be constructed in each phase to bring out the project benefit in each phase.
- ✓ Considering two rainy seasons, the foundation work shall be done before the principal rainy season.
- ✓ Major port of unloading is Georgetown. Most equipment and materials will be transported from Georgetown to the project sites by land. Berbice River is crossed by ferry services. This may be a bottleneck of the land transportation. Transport capacity shall be considered in the selection of equipment and materials and preparation of the construction plan.

7) Environmental and Social Consideration

The Project refers to i) Environment Protection Law of Guyana, ii) GWI's Environmental Guidelines for Construction Project and iii) JICA's Guidelines for Environmental and Social Consideration.

i) Environment Protection Law of Guyana

In the Environmental Protection Law, all the projects which deem to have environmental impact is required to apply for Environmental Permit to Environmental Protection Agency, Guyana (EPA). EPA judges necessity of an environmental impact assessment (EIA) based on the application. In case of the Project, EPA has judged that the Project will not be required to conduct EIA and EPA will submit Environmental Permit after the project sites are determined. Therefore no particular procedure will be required as far as the Environmental Protection Law is concerned.

ii) GWI's Environmental Guidelines for Construction Project

<Preliminary Screening>

GWI stipulates that projects of which project costs are estimated more than 5 million GYD are classified into three Environmental and Social categories below based on the preliminary screening to be conducted by GWI and Design and Environmental guidelines are applied depending on the category.

- ✓ No major issues identified: apply environmental guidelines for design and construction.
- ✓ Some issues of concern: apply environmental guidelines for design and construction, further environmental assessment of specific projects may be required.
- ✓ Major issues identified: prepare resettlement plans, compensation programs, and archaeological salvage/restoration plans as required, design and implement community consultation/information program, apply environmental guidelines for design and construction.

<Design Stage>

GWI carried out the preliminary screening when it applied for Environmental Permit of the Project to EPA and classified the Project "No major issues identified". Therefore, as the next step, it is required to carry out the design referring the GWI's Design Environmental Guidelines.

<Construction Stage>

The Guidelines define the tasks during the implementation stage together with time lines and responsibility and role of concerned parties as shown in Table 2.2.

It is required to assist GWI for the implementation of EMP by the contractor.

Table 2.2 Tasks of Environmental Management Plan (EMP)

Tasks	Timeline	Responsible party	Oversight
Public participation meeting	Immediately after contract award	GWI or Contractor	Public, GWI
Development of project EMP	Before breaking ground	Contractor	GWI
Train workers on EMP practices	Before breaking ground	Contractor	GWI
Audit EMP implementation	During Construction	Contractor	GWI

iii) JICA's Guidelines for Environmental and Social Consideration

The Preliminary Study for the Project classified the project as a Category B project and identified 6 environmental concerns. Table 2.3 shows the identified concerns and policies to be applied in the basic design.

Table 2.3 Environmental Concerns Identified by the Preliminary Study and Policies of Basic Design

Concerns	Policies of Basic Design
Impacts to groundwater	● Not to develop new wells and not increase total production rates. ● Not to concentrate the production to specific wells to avoid the increase of the production of certain wells.
Land Acquisition issues	● To exclude privately owned land to avoid land acquisition problems. ● To aim to select sites far from other building
Impacts of wastewater from WTP	● Not to be expected major problems from operation experience of WTPs in New Amsterdam and Rose Hall ● No wastewater is expected if slow sand filtration is adopted.
Impact of noise from WTP	● To install generators and compressors indoors.
Impacts to low income people	● No squatters and illegal people identified in the project area by the social survey in the Study. ● Coverage is 100%. No need to care for the new connection.
Impact concerned to construction works: • Interference to traffic and business activities by pipe installations and construction materials transportation. • Noise by construction works	● To apply construction methods that minimize the impacts to residents daily life. ● Mitigation methods will be prepared in EMP by a contractor. The implementation of EMP will be monitored.

2.2.2 Basic Plan

(1) Overall Plan

1) Target Year and Design Water Supply

Target year is set out 2015. Population in 2015 was estimated from 2002 census population by villages applying 0.75% of annual population growth rate. Estimated population is shown in Table 2.4. Population in 2015 was estimated at 36,598.

Table 2.4 Population Estimation in the Project Area

Year / Name of Village	2002 Census Population	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number 51	472	476	479	483	486	490	494	497	501	505	509	512	516	520
Number 52	359	362	364	367	370	373	375	378	381	384	387	390	393	396
Number 53 Union	539	543	547	551	555	560	564	568	572	576	581	585	590	594
Number 54	332	334	337	340	342	345	347	350	352	355	358	360	363	366
Number 0	390	393	396	399	402	405	408	411	414	417	420	423	427	430
Number 55	332	334	337	340	342	345	347	350	352	355	358	360	363	366
Number 56	247	249	251	253	254	256	258	260	262	264	266	268	270	272
Number 57 – Dead Tree Farm	501	505	509	512	516	520	524	528	532	536	540	544	548	552
Number 58 – Dead Tree Farm	506	510	514	517	521	525	529	533	537	541	545	549	553	558
Number 59	445	448	452	455	459	462	465	469	472	476	480	483	487	490
Number 60	447	450	454	457	461	464	467	471	475	478	482	485	489	493
Number 61	126	127	128	129	130	131	132	133	134	135	136	137	138	139
Number 62	287	289	291	294	296	298	300	302	305	307	309	312	314	316
Number 63 – Benab	224	226	227	229	231	233	234	236	238	240	241	243	245	247
Number 64 Babylon	1,726	1,739	1,752	1,765	1,778	1,792	1,805	1,819	1,832	1,846	1,860	1,874	1,888	1,902
Number 65 – New Market	1,006	1,014	1,021	1,029	1,037	1,044	1,052	1,060	1,068	1,076	1,084	1,092	1,100	1,109
Number 66	186	187	189	190	192	193	195	196	197	199	200	202	203	205
Number 67	627	632	636	641	646	651	656	661	666	671	676	681	686	691
Number 68 – Carnavorn	734	740	745	751	756	762	768	773	779	785	791	797	803	809
Number 69 – Friendship	857	863	870	876	883	890	896	903	910	917	923	930	937	944
Number 70 – Massiah	776	782	788	794	800	806	812	818	824	830	836	842	849	855
Number 71 – Little Massiah	777	783	789	795	801	807	813	819	825	831	837	844	850	856
Number 72 – Hong Kong	1,009	1,017	1,024	1,032	1,040	1,047	1,055	1,063	1,071	1,079	1,087	1,095	1,104	1,112
Number 73 – Clonbroke or La	532	536	540	544	548	552	556	561	565	569	573	578	582	586
Number 74 – Stockholm or Balaam	282	284	286	288	291	293	295	297	299	302	304	306	308	311
Number 75 – Spring Garden	319	321	324	326	329	331	334	336	339	341	344	346	349	352
Number 76 – Hariet	510	514	518	522	525	529	533	537	541	545	550	554	558	562
Number 77 (Housing development)*		0	0	0	250	500	750	1,000	1,250	1,500	1,750	2,000	2,250	2,500
Number 77	943	950	957	964	972	979	986	994	1,001	1,009	1,016	1,024	1,031	1,039
Springlands	4,313	4,345	4,378	4,411	4,444	4,477	4,511	4,545	4,579	4,613	4,648	4,682	4,718	4,753
Number 80 Skeldon	2,821	2,842	2,863	2,885	2,907	2,928	2,950	2,972	2,995	3,017	3,040	3,063	3,086	3,109
New Calcutta	2,641	2,661	2,681	2,701	2,721	2,742	2,762	2,783	2,804	2,825	2,846	2,867	2,889	2,910
Crabwood Creek	5,600	5,642	5,684	5,727	5,770	5,813	5,857	5,901	5,945	5,990	6,034	6,080	6,125	6,171
Jackson Creek	76	77	77	78	78	79	79	80	81	81	82	83	83	84
Total	30,942	31,174	31,408	31,643	32,131	32,620	33,111	33,603	34,098	34,594	35,093	35,593	36,095	36,598

Annual growth rate: 0.75%

＊：Including 700 houses to be developed by Central Housing and Planning Authority

Per capita consumption rate adopts 180 l/capita/day[6] based on the GWI Design Parameter. Maximum daily demand and maximum hourly demand are calculated by peak factors of the Design Parameter, 1.4 and 1.8 respectively. Design water supplies are determined as follows (the adopted for facility design in parentheses):

Average daily water supply: 6,588 m^3/day (6,600 m^3/day)
Maximum daily water supply: 9,223 m^3/day (9,300 m^3/day)
Maximum hourly water supply: 11,858 m^3/day (11,900 m^3/day)

[6] GWI Design Parameter, 180 l/capita/day consists of domestic use, 120 l/capita/day, commercial use, 15 l/capita/day, and un-accounted for water, 25% of a total (45 l/capita/day).

2) Service Level

The project area between No 51 Village and Moleson Creek is to be isolated from the existing distribution system by installing gate valves between Village 50 and Village 51. Water is supplied for 24 hour continuously with minimum 0.7kg/cm^2 of pressure[7] in the separated project area.

3) Water Quality

Target water qualities are set up as follows in accordance with GWI's Design Parameter:

- Iron: < 0.3mg/l[8]
- Turbidity: < 5NTU
- pH: 6.5 to 8.5
- Escherichia coli: 0 CFU/100ml
- Residual Chlorine: 0.2 to 0.5mg/l

GWI's water quality criteria for potable water follows WHO potable water quality standards. It was confirmed that water quality items other than Iron, Escherichia coli and Ammonium were within the standards by the water quality test[9] conducted in the Study.

Although WHO potable water quality standards includes various items, WTPs of the Project will be controlled only by the items specified in the Design Parameter because of the following reasons:

i) Water source is groundwater as deep as more than 200m and there exist at least two impermeable layers above the water source aquifer. Therefore, human activities on the surface hardly affect water quality of the aquifer.

ii) There are sugar cane and rice cultivations within several km from the shoreline towards inland and some pesticides could be used. However, there is no evidence of the residual pesticides in water bodies[10].

iii) WHO potable water quality guidelines include not only chemicals from human activities but also the natural origin. However, since the Project utilizes the existing water sources, it can be judged that there would be no hazardous chemicals with natural origin experientially.

[7] Based on GWI Design Parameter. It is considered reasonable because most buildings in the project areas are maximum two stories.
[8] In the service standards specified in the Operation license to GWI, target of iron concentration is relaxed to 0.5mg/l
[9] Water quality test in the Study collected samples from the 8 existing wells and water taps in distribution area of each well and analysed pH, Water temperature, Turbidity, Colour, Conductivity, Alkalinity, Calcium, Manganese, Iron, Nitrite, Nitrate, Ammonium, Escherichia coli, Arsenic, Silicate, Chloride, Copper, Fluoride, Cyan, Cadmium Mercury and Lead.
[10] Water quality test also analysed Aldrin, Dieldrin, Carbofuran, Endrin and Simazine for samples from No. 57 Village well and Queenstown well and results were all under the detection limit. According to Scoping Study of Presence of Pesticides in Drainage Canal Sediments and Drain Water in Guyana's Regions 3 and 5, 2004, Ministry of Agriculture which analysed 144 kinds of pesticides for samples from 3 waterways in Division 3 and Division 5, no residual chemicals were detected.

4) System Planning

<WTP>

Selection of WTP Site

No. 56 Village site and Queenstown site were selected from 7 candidates site presented by GWI as WTP sites by comparing their size, accessibility, ground conditions, ownership and impacts to surrounding areas. （Refer to Figure 2.1 for location of candidate sites and Table 2.6 for the comparison of candidates sites. Also refer to Drawing No. 002 and 013 in the Attachment-5 for detail location of No.56Village site and Queenstown site, respectively）

Alternatives of WTP Construction (Either one or two WTPs are planned to be constructed.)

Number of WTPs to be constructed is studied with 3 alternatives below:

Table 2.5 Alternatives of WTP Construction

Number of WTP	Case	Name of WTP to be constructed
1 WTP	1	No. 56 Village WTP
	2	Queenstown WTP
2 WTPs	3	Queenstown WTP + No. 56 Village WTP

Since No. 56 Village site is located almost the north end and Queenstown site is located slightly east of the centre of the project area. In case of 1 WTP, water is sent from water source well and after treatment water is sent back to distribution area. Therefore No. 56 Village site has a disadvantage in length of water transmission and this alternative (case-1) was eliminated from further discussion.

Case 2 and Case 3 are adopted as WTP construction alternatives for the system planning.

Selection of Water Treatment Methods

As the existence of iron bacteria in well water was confirmed by the iron bacteria test conducted in the Study, following two methods are compared as treatment alternatives:

i) Iron removal by rapid sand filtration after chemical oxidation of iron dissolved in well water (hereinafter called as rapid sand filtration).

ii) Iron removal by iron bacteria which develop on the surface of slow sand filter (hereinafter called as slow sand filtration).

Results of the comparison are shown in Table 2.7.

In general the slow sand filtration has an advantage in case raw water is clean and stable and plant site has enough area because it requires less mechanical equipment and less chemical dosing.

Figure 2.1 Location of WTP Candidate Sites

Table 2.6 Comparison of WTP Candidate Sites

No	Name of Sites (Location refer to Figure 2.1)	Conditions	Size	Land Ownership	Remarks	Evaluation
1	No.56 East	● About 200m off costal side of main road ● Next to cricket field	Approx. 100m x 120m	● MOHW ● NDC submitted no-objection letter	Suggestion of EPA	Selected
2	No.57	● About 500m off inland side of main road ● Solid field ● No.57 well inside	Approx. 110m x 180 m	● Privately owned		Excluded due to private land ownership
3	No.56 West	● About 500m off inland side of main road ● Deep bush ● Ground conditions un-known	At least Approx. 200m x 100m	● Un-known	Not presented at the Preliminary Study	Excluded.
4	Queenstown	● About 500m off inland side of main road ● Deep cane bush ● Surrounded by channels	At least Approx. 200m x 100m	● MOHW ● GUYSUCO used as cane field but already submitted the agreement to return it to MHS	Suggestion of EPA	Selected
5	Skeldon (Road side)	● Roadside of the main road between a Mosque and tax office. ● One squatter in the site ● Ground conditions good	At least approx. 46m x 74m	● Government owned land. But not allocated to MOHW yet.	Possible objections from Mosque	Excluded to avoid neighbourhood problems
6	Skeldon (River side)	● Near GUYSUCO jetty. ● Along the wastewater channel ● Bush ● Ground condition unknown	Max. 18m x 100m?	● Government owned land. But not allocated to MOHW yet		Land size is too small
7	Line Path	● Roadside of the main road. ● Just along the channel ● Old kids play yard ● Ground conditions good	Max approx. 28m x 100 m	● MHS		Land size is too small

* MOHW: Ministry of Housing and Water
NDC: Neighbourhood Democratic Council (Village 52 to 74)
GUYSUCO: Guyana Sugar Company
EPA: Environment Protection Agency

In case of the Project, although sites has enough space and raw water is clean and stable groundwater, it is concerned that civil work costs are high due to soft soil conditions that require foundation work and high cement price. Therefore indicative construction costs were calculated and compared as shown in Table 2.8. As a result of comparison, it was confirmed the construction cost of slow sand filtration is cheaper than the one of rapid sand filtration. In addition, the operation cost of slow sand filtration is much cheaper than the rapid sand filtration. Consequently, the slow sand filtration was adopted as a water treatment method of the Project.

Operation of the slow sand filtration requires scraping of the sand surface at a certain interval (every 2 to 3 months) to recover filtration rate that is lowered by clogging of sand by biomass of iron bacteria on the sand surface. GWI does not have this experience but it can master it by proper training.

GWI wants to challenge the slow sand filtration.

Table 2.7 Comparison of Iron Removal Methods

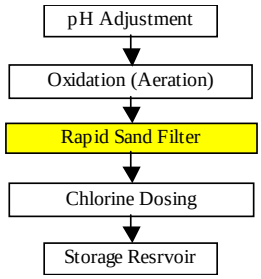
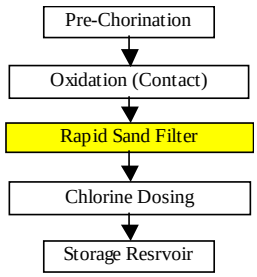
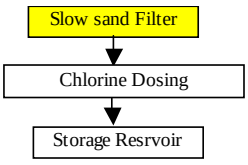
Iron Removal	Oxidation by Air + Rapid sand filtration	Oxidation by chlorine + Rapid sand filtration	Iron Bacteria + Slow sand filtration
Process flow			
Principle	Ferric ion is oxidized by oxygen in air forming insoluble ferrous compounds. Insoluble ferrous compound is removed by rapid sand filtration.	Ferric ion is oxidized by chlorine forming insoluble ferrous compounds. Insoluble ferrous compound is removed by rapid sand filtration.	Soluble ferric compound is captured by iron bacteria that grow on the surface of the sand filter. Captured ferric compound is oxidized to insoluble ferrous compounds and is accumulated in the iron bacteria.
Oxidant	Oxygen	Chlorine	Oxygen
Solid-liquid separation	Filtration	Filtration	Biological capture
Operational factors	Oxidation speed is lowered in lower pH.	Oxidation speed is lowered in lower pH.	Existence of iron bacteria in raw water.
Operation and Maintenance	Not difficult but require for skill to operate rapid sand filtration	Not difficult but require for skill to operate rapid sand filtration	Less operation work after iron bacteria developed. Require scraping work.
Operation Cost	High with electricity cost.	High with electricity cost and chlorine cost	Less cost with no chemical and less pump.

Table 2.8 Comparison of Construction Cost of Rapid and Slow Sand Filtrations

Items	Facilities	Detils	Chlorination + Rapid sand filtration process		Slow sand filtration process with iron bacteria	
			1 WTP	2 WTP	1 WTP	2 WTP
Construction Cost (million yen)	Piping work	Conduction line	97.2	11.2	97.2	11.2
			-	46.8	-	46.8
		Distribution line	497.6	83.8	497.6	83.8
			-	81.7	-	81.7
	sub-total		594.8	223.5	594.8	223.5
	Water treatment Plant	Civil & buildings	368.4	443.7	370.1	411.2
		Plants & machine	283.5	347.9	163.4	163.0
		Electric equipment	53.0	81.0	19.1	15.3
	sub-total		704.9	872.6	552.6	589.5
	Total		1,299.7	1,096.1	1,147.4	813.0
Operation & Maintenance Cost (million yen /20 years)	Personal expense		19.8	39.5	21.7	41.4
	Electric power cost		365.1	364.9	363.8	363.8
	Chemicals cost		19.6	19.6	10.0	10.0
	Total		404.5	424.0	395.5	415.2
Total (million yen) (Construction cost + O&M cost(20 years))			1,704	1,520	1,543	1,228

Note: Costs are only reference value and do not represent the project cost estimate.

<Selection of Water Source Wells>

Considering length of conduction to WTP and discharge capacity of each well, No. 57 Village well and Benab well are selected as potential water sources for No. 56 Village WTP and Queenstown well and Spring Garden well as potential water sources for Queenstown WTP. Required discharge of each wells and size and length of conduction pipe are shown in Table 2.9.

For water source well of No. 56 Village WTP, finally Benab well was eliminated because of long conduction pipeline and sufficient discharge capacity of No. 57 village well.

Table 2.9 Selection of Water Source Wells

Number of WTPs	WTP	Capacity	Well	Discharge	Size of Conduction pipe	Length of Conduction	Selection
		m^3/day		m^3/day	mm	m	
1 WTP	Queenstown WTP	9,300	Spring Garden	5,000	300	4,332	○
			Queenstown	4,300	200	100	
2 WTP	No. 56 Village WTP	3,800	No.57 Village	2,400	200	1,048	
			No.63Benab	1,400	200	4,826	
		3,800	No.57 Village	3,800	250	1,048	○
	Queenstown WTP	5,500	Spring Garden	3,000	250	4, 332	○
			Queenstown	2,500	150	100	

<Transmission from WTP to the Existing Distribution Trunks>

For the water transmission from WTPs to the existing distribution trunks, 7 alternatives were compared as shown in Table 2.10.

Table 2.10 Alternatives of Water Transmission from WTP to the Existing Distribution Trunks

Numbers of WTP	Alternative	Water Transmission
1 WTP	1 - 1	1 WTP + 1 Distribution block
	1 - 2	1 WTP + 2 Distribution blocks
	1 - 3	1 WTP + 3 Distribution blocks
	1 - 4	1 WTP + 4 Distribution blocks
2 WTP	2 - 1	No.56 Village WTP + 1 Distribution block, Queenstown WTP + 1 Distribution block
	2 - 2	No.56 Village WTP + 1 Distribution block, Queenstown WTP + 2 Distribution blocks
	2 - 3	No.56 Village WTP + 2 Distribution block, Queenstown WTP + 2 Distribution blocks

Heights of the elevated tanks of each alternative to maintain water pressure in the distribution network above 0.7 kg/cm^2 were calculated by hydraulic network analysis and alternatives 1 - 1, 1 - 2, 1 - 3 and 2 - 1 were eliminated because of their not practical required heights (more than 30m) of the elevated tanks.

For alternatives 1 - 4, 2 - 2 and 2 - 3 (refer to Figure 2.2), size and length of distribution mains which transmits required water amount keeping enough pressure with practical height of the elevated tank were determined by the hydraulic network analysis. Its results and the comparison of construction cost of each alternative are shown in Table 2.11. As result of the comparison, alternative 2 - 3 was selected as a water transmission system of the Project.

Table 2.11 Comparison of Construction Costs of Water Distribution Alternatives

Alternative plan of water supply system (WTP, conduction and distribution line)	Name of WTP	Capacity of WTP (m^3/d)	Distribution line			Elevated tank			Selec-tion
			Diameter (mm)	Length (m)	Construction cost (x10,000 yen)	Volume (m^3)	Height (m)	Lifting pump (kW)	
1－4 (1 WTP, 4 Connection points)	Queenstown	9,300	250	5,855	6,265	496	29	45 kW X 3 sets = 135 kW	×
			300	6,240	13,915				
			350	8,370	23,642				
			400	1,805	5,978				
			Total		49,800			135 kW	
2－2 (2 WTPs, 3 Connection Points)	No.56Village	3,800	350	4,284	12,101	203	36	22kW ×3sets = 66 kW	×
	Queenstown	5,500	250	7,647	8,183	293	25	22kW ×3sets = 66 kW	
		9,300	Total		20,284	496		132 kW	
2－3 (2 WTPs, 4 Connection points)	No.56Village	3,800	250	7,836	8,385	203	19	15 kW ×3 sets = 45 kW	○
	Queenstown	5,500	250	7,635	8,170	293	25	22kW ×3sets = 66 kW	
		9,300	Total		16,556	496		111 kW	

Note: Costs are only reference value and do not represent the project cost estimate

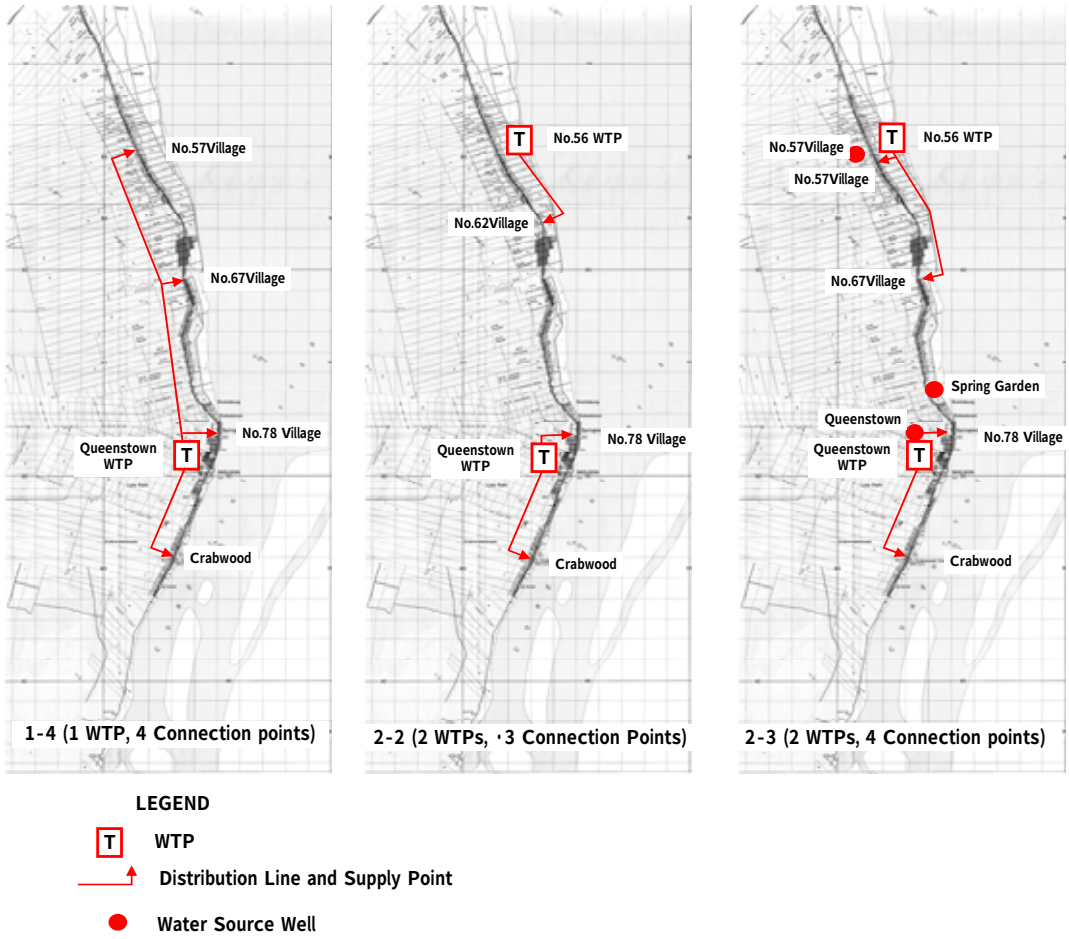


Figure 2.2 Alternatives of Water Transmission

<Selected System>

Flow diagram of the selected facility system is shown Figure 2.3 and their facility locations are shown in Figures 2.4 and 2.5.

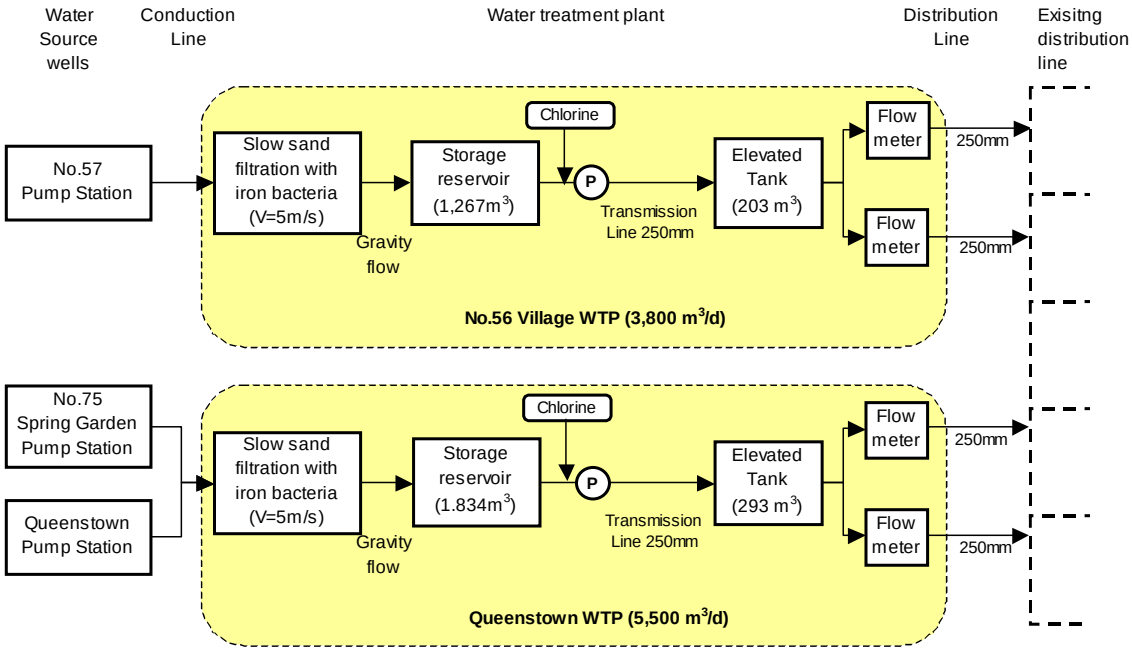


Figure 2.3 Facility System of the Project

Figure 2.4 Location of Facilities (No.56 Village WTP)

Figure 2.5 Location of Facilities (Queenstown WTP)

(2) Facility Plan

1) Water Source Wells

For the water source wells selected as water sources for WTPs, lift pumps are replaced with ones with proper specifications for the required head and discharge and new emergency generators are installed. The existing wells that will be not used for the WTPs will be left as they are and used as back up wells to supplement water supply in emergency cases.

Table 2.12 Facility Plan of Water Source Wells

Name of wells	WTP	Capacity of Emergency Generator	Replacement of Pumps	
No.57Village Well	No.56 Village WTP	220kVA	Discharge (m^3/min)	2.64
			Head (m)	53
			Output (kW)	45
Spring Garden Well	Queenstown WTP	150kVA	Discharge (m^3/min)	2.08
			Head (m)	65
			Output (kW)	37
Queenstown Well	Queenstown WTP	Not installed. Power is supplied from the emergency generator of Queenstown WTP.	Discharge (m^3/min)	1.74
			Head (m)	40
			Output (kW)	18.5

2) Conduction pipeline

Conduction pipe were designed for the maximum daily rates. All the conduction pipe will be buried under public ways. Size and length of the conduction pipelines are summarized in Table 2.13.

Table 2.13 Size and Length of Conduction Pipelines

WTP	Section	Material	Size (mm)	Length (m)
No.56 Village WTP	From No.57 Village well to No.56 Village WTP	Rigid PVC	250	1,048
Queenstown WTP	From Spring Garden well to Queenstown WTP	Rigid PVC	250	4,332
	From Queenstown well to Queenstown WTP	Rigid PVC	200	100

3) WTP

Two WTPs, No.56 Village WTP and Queenstown WTP, will be constructed. WTPs were designed based on the following concepts:

i) WTP is designed based on the maximum design daily water supply rate. It dose not have a back wash process since slow sand filtration is employed.

ii) In the Project, the filtration rate is set to be 5 m/day, on account that the normal rate is 4 – 5 m/day which is stated in “Guidelines for water supply facility design (Japan Water Works Association, 1999)”. Numbers of filter basins are to be three or four, that include a standby basin, and their filtration rates are to be kept under 7 m/day even when one basin is stopped, since the guidelines require two or more basins including standby and maximum filtration rate in good water quality is to be 8

m/day.

iii) Volume of storage reservoir is designed to have a capacity of 8 hour detention time to the maximum design daily water supply rate.

iv) Elevated tank shall have one our detention time to the maximum design hourly water supply rate and capacity of the lift pump shall have the design maximum hourly rate.

v) Chlorine disinfection employs gas chlorine and protective measures against the chlorine leakage shall be provided.

Facility plan of two WTPs are shown in Table 2.14. Ground level of the WTP is designed at +17.79m with 750mm filling on the existing ground level (+16.96m). Construction of the filter, storage reservoir, elevated tank and building apply pile foundation.

Design calculations are shown in Table 2.15.

Table 2.14 Facility Plan of WTPs

WTP	Distribution Area	Capacity	Facility/equipment
No.56Village	Population: 15,000 Area: From No.51Village to No.73Village	Maximum Daily: 3,800m^3/day Maximum Hourly: 4,870m^3/day	Slow sand filter, Storage reservoir, Lift pump, Elevated tank, Chlorine injector, Sand washing tank with storage, Emergency generator, Water quality test kit, Transformer, Office building
Queenstown	Population: 21,600 Area: From No.74Village to Moleson Creek	Maximum Daily: 5,500m^3/day Maximum Hourly: 7,030m^3/day	

Table 2.15 Design Calculations

Facilities	No. 56 Village WTP	Queenstown WTP
Receiving Chamber	Retention time: 15mins. Vol: 2.639m^3/min x 15 min＝39.6m^3. W5.0m×L3.0mxH3.1m (Ef. Depth :2.65m)	Retention time: 15mins. Vol: 3.189m^3/min x 15 min＝57.3m^3. W6.0m×L3.0mxH3.1m (Ef. Depth :2.65m)
Slow Sand Filtration	Filtration rate: 5m/day. Area: 3,800m^3/day / 5.0m/day = 760m^2. Filtration layer: Sand 0.7m + Gravel 0.5m = 1.2m. Filtration depth: 1.2m. Overboard: 0.5m. Collector: Perforated pipe. W14.0m x L20.0m x H2.9m（Eff. Depth: 2.4m）x 3 beds. Flirtation rate in 2 bed operation: 6.8m/day	Filtration rate: 5m/day. Area: 5,500m^3/day / 5.0m/day = 1,100m^2. Filtration layer: Sand 0.7m + Gravel 0.5m = 1.2m. Filtration depth: 1.2m. Overboard: 0.5m. Collector: Perforated pipe. W14.0m x L20.0m x H2.9m（Eff. Depth: 2.4m）x 4 beds. Flirtation rate in 3 bed operation: 6.5m/day
Storage Reservoir	Retention time: 8 hrs. Vol: 158.3m^3/hr x 8hrs = 1,267m^3. Depth: 3m, Area: 1,267m^3 / 3m＝423m^2. W10.0m x L21.2m x H3.7m (Eff. Depth: 3.0m) x 2.	Retention time: 8 hrs. Vol: 229.2m^3/hr x 8hrs = 1,834m^3. Depth: 3m, Area: 1,834m^3/ 3m＝612m^2. W910.0m x L30.6m x H3.7m (Eff. Depth: 3.0m) x 2.
Lift Pump	3 pumps including 1 stand-by. Capacity: 3.382m^3/min / 2min = 1.69m^3/min.	3 pumps including 1 stand-by. Capacity: 4.882m^3/min / 2min = 2.44m^3/min.

Facilities	No. 56 Village WTP	Queenstown WTP
	Head: 23.0m. Shaft power: 0.163 x 1.0 x 1.69 x 23/0.70 = 9.44kW. Motor power: 9.44 x 1.15 = 9.05kw ≈ 15kW.	Head: 29.0m. Shaft power: 0.163 x 1.0 x 2.44 x 293/0.73 = 15.80kW. Motor power: 15.88 x 1.15 = 18.17kW ≈ 22kW.
Elevated Tanks	Retention time: 1 hr. Vol: 202.9m^3/ hr x 1.0hr = 203m^3. Effective depth: 2.6m. ϕ10m x H3.0m（Effective depth: 2.6m）. Height of tank bottom: 19.0m.	Retention time: 1 hr. Vol: 292.9 m^3/ hr x 1.0hr = 293m^3. Effective depth: 2.6m. ϕ12m x H3.0m（Effective depth: 2.6m）. Height of tank bottom: 25.0m.
Disinfection Equipment	Disinfectant: Chlorine gas. Dosing rate: 1.0mg/l. 3,800m^3/day x 1.0mg/l = 3.8kg/day. Injection pump: 0.08m^3/min x 43m x 2.2 kW x 2 pumps (1 stand-by). Equipped with leakage detector.	Disinfectant: Chlorine gas. Dosing rate: 1.0mg/l. 5,500m^3/day x 1.0mg/l = 5.5kg/day. Injection pump: 0.08m^3/min x 43m x 2.2 kW x 2 pumps (1 stand-by). Equipped with leakage detector.
Flow Measuring Equipment	Type: Turbine type meter. Range: 0 - 300m^3/hr. One meter for each distribution line.	Type: Turbine type meter. Range: 0 - 400m^3/hr. One meter for each distribution line.

4) Distribution Main Pipeline

Height of elevated tank, location of connection point of the distribution main pipe to the existing distribution trunk pipe and size of the pipe were designed so that the existing distribution trunks can be utilized as much as possible. Also maximum size of PVC pipe made in Guyana (250mm) is taken into consideration. Facility plan of the distribution main pipelines is shown in Table 2.16.

Table 2.16 Facility Plan of Distribution Main Pipeline

WTP	Elevated Tank	Pipe No	Size (mm)	Connection Point	Length (m)
No.56Village WTP	Volume: 203m^3 Height: 19.0m	No.1	ϕ250	No.57Village	798
		No.2	ϕ250	No.67Village	7,038
Queenstown WTP	Volume: 293m^3 Height: 25.0m	No.3	ϕ250	No78 Springlands	1,805
		No.4	ϕ250	Crabwood Creek	5,830

(3) Equipment Plan

1) Number of Water Meter

Number of water meter to be procured was 9,800 in the original request. The purpose of the procurement of the water meter is to install the water meter to all the customers in the project area to measure water consumption rates and apply metered tariff. Therefore, number of customers in 2015 was estimated as shown in Table 2.17 and number of the water meter procured was determined 8,400.

Table 2.17 Estimation of Number of Customers in the Project Area in 2015

Customers in 2005*	Estimated population in 2005**	Number of persons per customer	Estimated population in 2015**	Estimated number of Customers in 2015
7200	31,643	4.4	36,598	8,318

*:Source, GWI Division 5 Customer records.
**:Source, this study.

2) Accessories

During the site survey in the Study, many leakages caused by poor plumbing work due to improper pipefittings were observed. Therefore, to ensure proper installation accessories of water meter are included in the procurement. Also meter box is included to protect the meter.

Specifications and quantity of water meter and accessories are shown in Table 2.18.

Table 2.18 Specifications and Quantity of Water Meter to be Procured

Items	Specifications	Quantity
Water Meter	Digital volumeter, 3/4 inch	8,400
Accessories	Valve, Socket	8,400sets
Meter box	Plastic, Fixing on ground surface	8,400

2.2.3 Basic Design Drawings

List of drawings of the basic design is shown below and each drawing is attached in the back of this report.

Drawing No.	Drawings	
001	Whole Project	General Plan
002	No.56VillageWTP	General Plan
003	No.56VillageWTP	Flow Diagram
004	No.56VillageWTP	Plan
005	No.56VillageWTP	Water Level Profile
006	No.56VillageWTP	Slow sand filter - Plan
007	No.56VillageWTP	Slow sand filter-Cross Section
008	No.56VillageWTP	Storage reservoir - Plan
009	No.56VillageWTP	Storage reservoir - Cross Section 1
010	No.56VillageWTP	Storage reservoir - Cross Section 2
011	No.56VillageWTP	Elevated tank
012	No.56VillageWTP	General Plan of Pipeline
013	Queenstown WTP	General Plan
014	Queenstown WTP	Flow Diagram
015	Queenstown WTP	Plan
016	Queenstown WTP	Water Level Profile
017	Queenstown WTP	Slow sand filter - Plan
018	Queenstown WTP	Slow sand filter-Cross Section
019	Queenstown WTP	Storage reservoir - Plan
020	Queenstown WTP	Storage reservoir - Cross Section 1
021	Queenstown WTP	Storage reservoir - Cross Section 2
022	Queenstown WTP	Elevated tank
023	Queenstown WTP	General Plan of Pipeline

2.2.4 Implementation Plan

(1) Implementation Policy

<Project Implementation System>

The Project is implemented in accordance with the conditions described in the Exchange of Notes (E/N) between the both governments. Guyanese executing agency of the Project is the Ministry of Housing and Water and GWI is responsible for the implementation of the Project. GWI will be responsible for the operation and maintenance of the facilities and equipment to be provided by the Project. GWI will hire consultants in the implementation of the Project to obtain detailed design, preparation of tender documents, tender assistant, management of the construction and procurement and execution of the soft component of the Project. In the implementation of the construction work, local contractors shall be utilized as much as possible. Organizations concerned in the Project and their relation are shown in Figure 2.6.

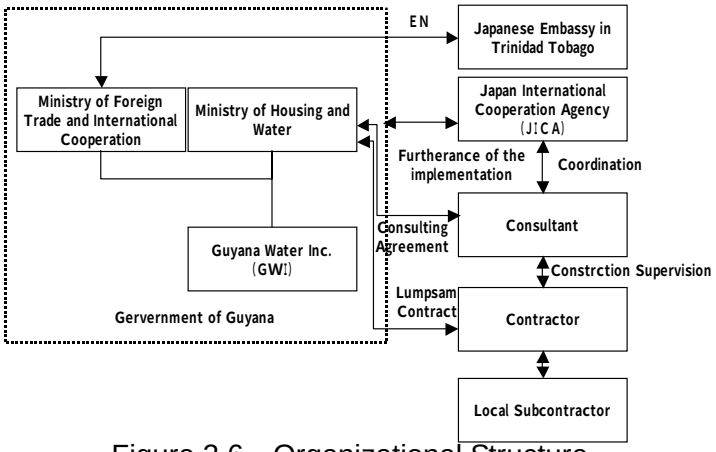


Figure 2.6 Organizational Structure of Project Implementation

(2) Implementation Conditions

<Access>

WTP sites face to the public road and all the conduction and distribution mains are buried under the public way. Therefore, there would be no need to construct new access to the construction sites. However, most roads other than the main road are not paved. Therefore, most access roads are required to be improved by gravel pavement, widening and filling.

<Resettlement>

WTP sites are selected from land owned by the Ministry of Housing and Water to avoid possible complains from surroundings. Therefore, no settlement and problems concerned with land acquisition are expected.

<Business Area>

A part of the conduction pipeline from Spring Garden well to Queenstown WTP and distribution main pipe from Queenstown WTP to Springlands connection point are buried in about 2 km of Corriverton urban area. In this area people use the road shoulders as parking space and business activities. Pipe installation in this area could interrupt their daily activity but it would be unavoidable because no alternative routes are available. To minimize the interruption, it is required to divide the work section into small size in which all the work such as excavation, laying down, back filling and repavement, can be completed within one day.

<Water Cut>

Water cut would be unavoidable in the Project for the connection work of distribution main pipe to the existing distribution trunk pipelines. Presently water supply in the project area is not 24 hour continuously. It starts from 6:00 am and ends 6:00 pm in general. Therefore, it would be possible to minimize the impacts of the water cut by the Project by putting it after 6:00pm and before 6:00 am.

＜Environmental and Social Consideration＞

Environmental and social consideration in the implementation is achieved by following GWI's Environmental Guidelines.

GWI's Environmental Guidelines require the execution of following 4 activities:

- Public participation meeting
- Development of project EMP
- Train workers on EMP practices
- Audit EMP implementation

Contractor will execute the above and GWI is responsible for the supervision. Consultant will assist GWI so as EMP to be implement definitely.

(3) Scope of Works

In case where the Project is implemented, scope of work of the Japanese side and the Guyanese side is as shown in Table 2.19.

Table 2.19 Scope of Work of the Japanese Side and Guyanese Side

Items	Japanese Side	Guyanese Side
(1) To secure temporary work sites		○
(2) To secure WTP sites		○
(3) To cut over WTP sites		○
(4) To secure access to the existing wells		○
(5) To secure space for emergency generator and fuel tank in the existing well site.		○
(6) To construct of access to WTP	○	
(7) To provide information on underground burial objects and to present at excavation work		○
(8) To present at the connection work of new pipeline and the existing pipeline and to announce water cut off to the residents.		○
(9) To provide flushing water for pressure tests.		○
(10) To coordinate with chlorine disinfection of new pipelines.		○
(11) To draw in the electric power line to the project sites		○
(12) To conduct trial excavation to locate the burial objects.	○	
(13) To construct project facilities.	○	
(14) To conduct flushing and pressure test of conduction pipeline.	○	
(15) To conduct flushing and pressure test of distribution main pipeline.	○	
(16) To conduct water tightness test of WTP facilities.	○	
(17) To procure water meters	○	
(18) To install water meters procured.		○

(4) Consultant Supervision

If the Project would be implemented under the Japan's Grant Aid Scheme, the consultant will be engaged to provide the services for the Soft Component, Detailed Design and Construction Supervision for the implementation of the Project.

<Detailed Design>

In the stage of the detail design, following consulting services will be carried out.

- In the field survey, the investigation, topographic survey and test digging will be carried out such as site reconnaissance along the proposed pipelines routes, investigation on underground structure and obstacles (power cable, telephone cables, culverts, etc.,), investigation on existing water pipelines.
- Based on the results of the field survey, the basic design will be reviewed.
- The construction plan will be reviewed with due examination on the construction methods and structures of proposed facilities and temporary works.
- Structural calculation for planned and temporary facilities will be carried out.
- Drawings are prepared, such as location maps, plans, longitudinal profile, cross section and structural drawings.
- Quantity survey will be carried out.
- The contents of the basic design will be examined through confirmation of the basic conditions, validity of design, consistency between drawings and calculations.
- The project cost will be reviewed on the basis of the quantity and scale of the facilities determined by the detail design.
- Tender documents will be prepared in conformity with the guideline of Japanese Grant Aid.
- In the stage of the selection of the contractor, the consultants will support the implementing organization of Guyana in order to conduct tendering according to the guidelines of Japan's Grant Aid.

<Construction Supervision>

The consultants will undertake the construction supervision in the stage of the implementation of the Project. Major services are summarized below.

- Close coordination with both the parties concerned of Guyana and Japan in order to complete the Project in accordance to the planned construction schedule. The Guyanese concerned parties are Ministry of Foreign Trade and International Cooperation, Ministry of Housing and Water and GWI, and Japanese concerned parties are Ministry of Foreign Affairs, Embassy of Japan in Trinidad and Tobago, JICA and a Japanese contractor.
- Precise and timely advice to the contractor so as to construct the facilities in compliance with the design and specifications.
- Proper advice and transfer of the knowledge to the staff concerned on the appropriate operation and maintenance (O&M) work of the constructed facilities.
- Due coordination with GWI, NDC and residents in order to minimize the impacts to the residents during the pipe laying works.

- Preparation of comprehensive O&M manual for the constructed facilities. Specific manual for each equipment or facilities should be prepared by the manufacturer. The consultants will combine them into a comprehensive O&M manual.

The above services are carried out through the following activities:

i. Schedule control and quality control such as approval and inspection of materials, equipment and construction works
ii. Examination and implementation of the design changes, if necessary
iii. Progress report (monthly progress, completion report, etc.,)
iv. Inspection of safety control of the contractor
v. Assistance to the execution of EMP by the contractor
vi. Final inspection on the occasion of the completion

The above works are required to carry out continuously from the commencement of the work to the completion. A resident engineer will be assigned as a chief supervisor of the Project. The chief supervisor should be an enough experienced engineer in managing the entire construction works of water supply facilities. In addition, engineers specialized for water treatment facilities and mechanical equipment will be dispatched at the commissioning stage to examine the performance of the facilities constructed

(5) Quality Control Plan

Quality control of equipment will be carried out by on the spot visit at manufacturer's sites. Quality control of the site works will be carried out through the following tests.

➢ Foundation work:	Rebound test, Static load test
➢ Compaction work for structural fill:	Material test, Density test
➢ Concrete placement work:	Trail mix, Compression test, Casting joints inspection
➢ Reinforcement work:	Tensile and bending stress tests, factory certificates.
➢ Piping work:	Pressure test.
➢ Other structures:	Production inspection, Water tightness test

In addition, performance test (water quality and treatment capacity) of WTP will be carried out during the commissioning stage.

(6) Procurement Plan

<Labour>

Foremen, skilled labours and labours will be employed in Guyana.

<Construction materials>

Following construction materials are available in the local market:

Cement
Aggregate
Reinforcement

Formwork materials
Wooden materials for construction
Fuel

<Equipment>

Major equipment except PVC pipe (less than 250 mm) to be used in the Project such as submergible pumps, chlorine dosing equipment, emergency generators, lift pumps, filter media, steel and PVC pipes larger than 250 mm and the other materials are not produced in Guyana and not available in the local market. Therefore, they will be imported from Japan or the third countries such as the United States and EU.

<General Construction Machines>

There are leasing companies for the construction machines in Georgetown. Therefore general construction machines are available in Georgetown.

Procurement plan is summarized in Table 2.20.

Table 2.20 Procurement Plan

Items	Guyana	Third Countries	Japan	Remarks
Submergible pumps		○	○	
Chlorine dosing equipment		○	○	
Emergency generators		○	○	
Lift pumps		○	○	
Filter media		○		Japanese product may be costly due to long transportation
Steal lumbers		○	○	
Pipe (PVC less than 250mm)	○			
Pipe other than the above		○	○	
General Construction Material				
Cement	○			
Aggregates	○			
Reinforcement	○			
Formwork materials	○			
Fuel	○			

(7) Technology Transfer (Soft Component) Plan

1) Background

The Project adopts the slow sand filtration method as water treatment measures. The operation of the slow sand filtration is rather simple compared to the rapid sand filtration. Guidance of the operation methods of each equipment will be provided during the commissioning stage and the consultant will prepare overall operation and maintenance manuals.

However, GWI has operational experiences of only the rapid sand filtration in New Amsterdam, Rose Hall and other cities. Therefore, GWI needs operational skills and technical knowledge to ensure GWI's proper operation and maintenance of the slow sand filtration.

The Project provides GWI with such skill and knowledge of the slow sand filtration through a technology transfer program as part of the Project, which is called as Soft Component.

2) Targets

Targets of the soft component are as follows:

- To understand principles of slow sand filtration and iron removal by iron bacteria.
- To master the general operation skill of WTP.
- To acquire operational data necessary for the daily operation.
- To utilize the acquired data.
- To prepare operation and maintenance plan including sand scraping.

Soft component targets at persons (4 persons with Scale DS1) supposed to be assigned as a plant operator.

3) Contents of Soft Component

Contents of the soft components and expected achievement are shown in Table 2.21.

Table 2.21 Expected Achievements

Inputs	Expected Achievements
i) Seminor on theory of slow sand filtration and iron removal by iron bacteria ii) On the job training of slow sand filtration opearion iii) Preparation of operation and maintenance iv) On the job training of slow sand filtration maintenance v) Guidance of sand scraping and washing vi On the job training of preparation of operation and maintence plan	・ Understand theory ・ Master operational skills of slow sand filtration ・ Master operation and maintenance of sand filtration ・ Master skill of sand scraping, sand washing. ・ Prepare operation and maintenace plan for WTP

4) Confirmation of Achievement

Consultant responsible for the execution of the soft component comprehends the achievements shown in Table 2.22 and submits reports compiling the achievement to the Japanese side and the Guyanese side.

5) Input Plan

The Project will construct two WTP with slow sand filtration. Soft component training will be carried out in No. 56 Village WTP which will be in operation immediately after the completion of the phase 1. Therefore GWI is required to assign 4 operators of No. 56 Village WTP for training before the phase 1 completion. Such operators are recommended to include those having experiences in operation and maintenance of WTP.

Considering the time required to clog filters, estimating it about some ten days, length of soft component is set at approximately 2 months. Input plan is shown in Table 2.23.

Table 2.22 Confirmation of the Achievement

Achievements	Audit Methods
Understanding theory of slow sand filtration and iron removal	・ Through discussions in seminor and on the job training.
Mastering skill of slow sand filter operation	・ Through discussions in seminor and on the job training. ・ Checking daily operarion records prepared by operators
Mastering opearation of maintenace of slow sand filtration	・ Capability to adjust filtration rates depending on the operation conditions. ・ Checking daily operarion records prepared by operators ・ Practical exercise of reading of filtration resistence ・ Practical understanding of daily fluctuation of water consumption fluctuation. ・ Relation between WTP opearation and water consumption fluctuation..
Mastering skill of sand scraping and washing	・ Procedures of sand scraping. ・ Timing of sand scraping required. ・ Skill to scrape sand without distubing sand layers. ・ Skill to wash sand with minimum loss.
Capability of opearation and maintenance plan.	・ Peparation of plan considering water consumption fluctuation. ・ To predict the timing of the next sand scraping. ・ Preparation annual operation plan considering long term activities.

Table 2.23 Input Plan

Items	Period	Activities	Work in Japan				Work in Guyana			
			Actual days		Calendar days		Actual days		Calendar days	
			Jap.	Local	Jap.	Local	Jap.	Local	Jap.	Local
Seminar	1 day x 2 times	・ Execution of seminar ・ Report on OJT ・ Seminar on O&M plan	0.0	0.0	0.0	0.0	2.0	0.0	2.8	2.8
Preparation of Manuals	Japan 10 days Guyana 10 days	・ Preparation of Manuals (in Japan) ・ Preparation of Manuals ・ Hearing with local people	10.0	0.0	14.0	0.0	10.0	0.0	14.0	14.0
On the job training of WTP with slow sand filtration	30 days	・ Confirmation of intelligibility of manuals ・ Lectures ・ Trail operation ・ Data acquisition ・ Preparation of Operation record ・ Preparation of sand scraping work plan	0.0	0.0	0.0	0.0	30.0	0.0	42.0	42.0
Total (days)					14.0	0.0			58.8	58.8
(months)					0.47	0.0			1.97	1.97

6) Procurement of Resource

Considering difficulty in procuring consultants capable for soft component activities in Guyana and surrounding countries, Japanese consultant will be assigned to execute the soft component. Japanese consultant (specialist for water treatment management) will be dispatched for 2 months to Guyana and a local consultant (water quality specialist) will be hired as an assistant.

7) Schedule of Soft Component

The schedule of the soft component is shown in Table 2.24.

Table 2.24 Schedule of Soft Component

Work Items	Activities	Mobilization			First Month			Second Month		
		10	20	30	10	20	30	10	20	30
Seminar	Seminar on slow sand filtration and iron removal									
	Report on on the job training									
	Seminar on achievement of on the job training									
Preparation of Manual	Preparation of Manulas (in Japan)									
	Preparation of Manulas (in Japan)									
	Hearing to local people									
On the job training	Confirmation of intelligibilityof manual									
	Lecture with using actual plant									
	Trial operation									
	Data acquisition									
	Prepararion of operarion record									
	Work plan of scraping									

8) Deliverables of Soft Component

Deliverables of the soft component are as follows:

Table 2.25 Delivarables of Soft Component

Items	Deliverables
Seminar	・Hand outs ・Seminar report
Manuals	・Operation manuals of slow sand filtration
On the job training	・Daily report of on the job training ・Management daily report ・Operation and Maintenance plan

9) Cost of Soft Component

The approximate cost was estimated at 6,533 thousand Japanese Yen.

10) Obligation of Guyanese Side

The Guyanese side is required to assign persons who have capacity and motivation to achieve the targets of the soft component.

(8) Implementation Schedule

Tentative schedule is shown in Figure 2.7.

The project is implemented in two phases. Major project components of each phase are shown below.

Phase 1

- ✓ Rehabilitation of No.57 Village well.
- ✓ Installation of conduction pipeline from No.57 Village well to No.56 Village WTP.
- ✓ Construction of No.56 Village WTP.
- ✓ Installation of distribution main pipelines from No.56 Village WTP to the existing distribution trunk line.
- ✓ Procurement of water meters

Phase 2

- ✓ Rehabilitation of Spring Lands well and Queenstown well
- ✓ Installation of conduction pipelines from Spring Lands well and Queenstown well to Queenstown WTP.
- ✓ Construction of Queenstown WTP.
- ✓ Installation of distribution main pipelines from Queenstown WTP to the existing distribution trunk line.
- ✓ Implementation of the soft component

2.3 Obligations of Recipient Country

2.3.1 Undertakings

Undertakings of the Government of Guyana confirmed at the beginning of the Basic Design Study are as follows:

i) To provide available relevant data, information and materials necessary for the project.
ii) To secure land for the water treatment plants to be constructed in the project.
iii) To bear commissions required for the Authorization of Pay and the Banking Arrangement.
iv) To ensure prompt unloading and custom clearance of the products for the project.
v) To exempt Japanese nationals from custom duties, internal taxes and fiscal levies which may be imposed in Guyana with respect to the project.
vi) To bear all the expenses, other than those covered by the Japan's Grant Aid, necessary for the project.
vii) To ensure that the facilities and the equipment provided by the project be maintained and used properly and effectively.

2.3.2 Undertakings Specific to the Project

Undertakings identified by the Study are as follows:

i) To install all the water meters procured by the project before the completion of the project.
ii) To assign 4 operators of No.56 Village WTP before the completion of the 1st phase of the project and 4 operators of Queenstown WTP before the completion of 2nd phase. The operators of No.56 Village WTP are an intended target group of the soft component of the project (software assistant).

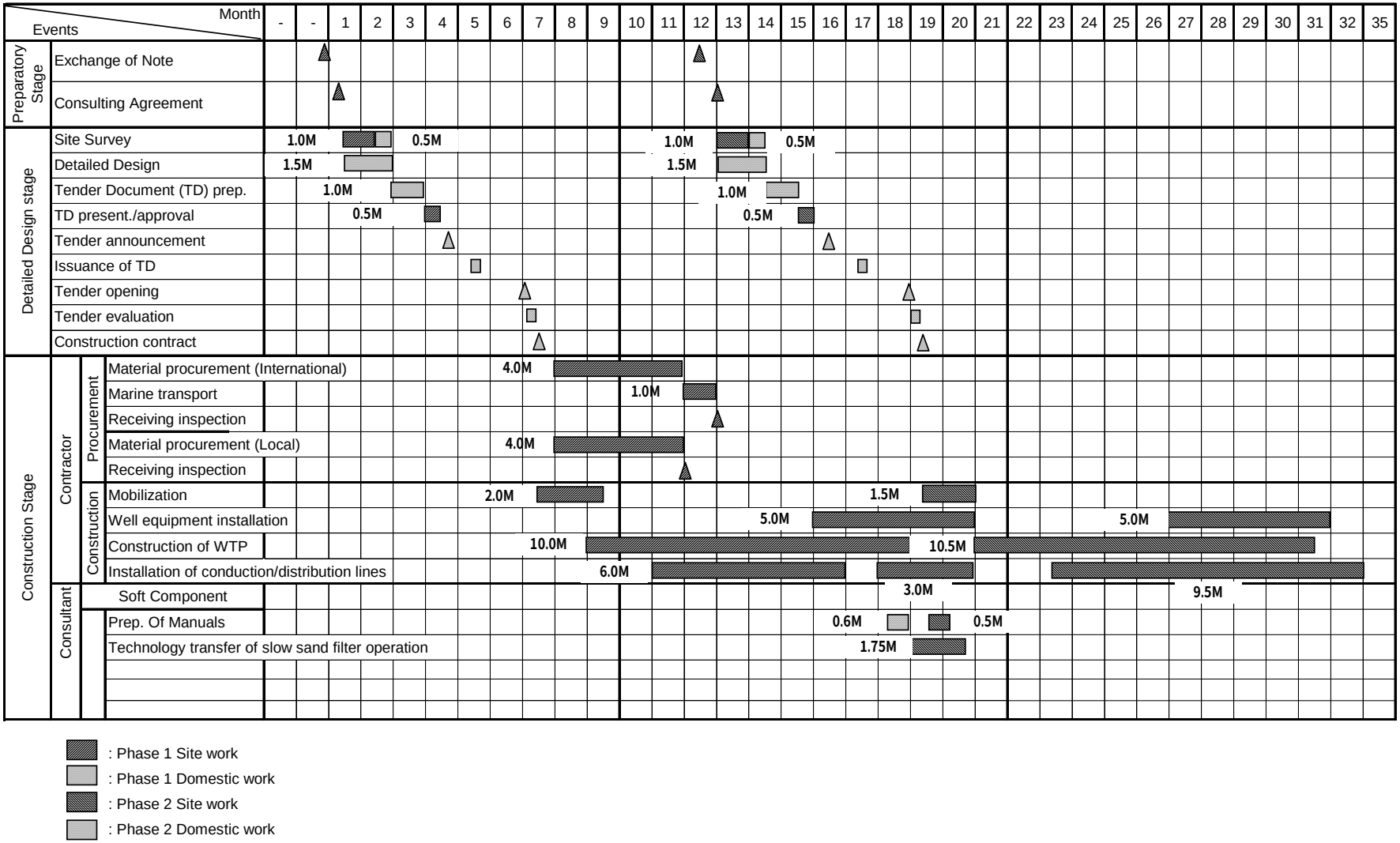


Figure 2.7 Implementation Schedule

iii) To complete the drawing in work of electric power line to the project sites within the time specified.

iv) To secure space for the installation of an emergency generator and its fuel tank in No.56 Village Well, Spring Garden Well and Queenstown Well sites.

v) To held meetings to present construction works inviting residents along pipeline routes prior to the commencement of the work. Special attentions shall be paid to the residents along Corriverton urban area as the work may cause some interruption of their daily and business activities along the main road.

vi) To publicize water supply cut off to the residents and to present at the sites of pipe joint works requiring water cut off.

vii) To secure land for No.56 Village WTP and Queenstown WTP and to cut over the Queenstown WTP prior to the commencement of the work.

viii) To secure land next to the No.56 Village WTP and Queenstown WTP for the temporary yards.

ix) To provide the contactor with water for pipe washing, pressure tests and water tightness tests.

2.4. Operation and Maintenance Plan (O & M) of the Project

2.4.1 O & M of the Project Facilities

Facilities of the project will be operated and maintained by the Division 5 of GWI. Currently, water is directly supplied to the customers from 8 wells by pressurized flow by well pumps. After the project, water from three wells among present 8 wells is sent to WTP through the conduction pipe line and after treating water is sent to the distribution network from the elevated tanks. Therefore, the project facilities will newly require WTP and conduction and distribution main pipelines operation. Meanwhile for the well operation, as ultimately 3 wells, presently 8 wells are in operation, are used in the project system, work load for the well operation will be reduced. Expected changes of the operation and maintenance work are summarized in Table 2.26.

Operation of the project facilities requires supply of chlorine and filter sand. Chlorine will be imported through a trading company in Guyana as it is being done in New Amsterdam and Rose Hall WTPs in Division 5. Filtration sand which is scraped off from filter beds will be reused after washing and drying. Therefore, the replenishment will be hardly necessary.

Spare parts of pumps will be procured as it is done presently by not adopting special equipment.

Table 2.26 Expected Changes of Operation and Maintenance Work after Project

Facilities	Present Operation and Maintenance	Expected Changes after Project	Remarks
Water Source Wells	● 3 mobile operators (2 on duty and 1 off) visit 8 wells 3 times a day. ● Pumps are operated from 6:00AM to 6:ooPM ● Pump operations are monitored and water flow rates are recorded.	● Ultimately 3 wells are operated in the system. ● Monitoring of operation conditions and recording of flow rates will be conducted as same way as the present.	It would be possible to reduce 1 mobile operator ultimately.

Facilities	Present Operation and Maintenance	Expected Changes after Project	Remarks
Conduction pipeline （New Facility）	● New conduction lines are equivalent to the present water transmission line from wells to the existing distribution trunks. ● Mobile operators monitor the pipeline and linesmen fix troubles.	● Operation and maintenance can be done by the present teams.	
WTP （New Facility）	<Reference> 4 operators are working in each WTP in New Amsterdam and Rose Hall.	● Inspection and adjustment, if required, of water receiving from the water source wells, inlet to the slow sand filters, operation conditions of the lift pumps and chlorine dosing. ● Monitor of the storage reservoir level and stopping operation of water source wells. ● Sand scraping when head loss exceeding the given limit. ● Water quality check (pH, turbidity, iron) once a day. Other items including faecal coliform shall be checked by the periodical water quality test of GWI Division 5. ● Work in 3 shifts, 1 operator for 1 shift and 1 operator stand-by, total 4 operators per one WTP.	2 groups of operator are required. 1 group= 3 on duty + 1 stand-by.
Distribution main pipeline (New facility)	Same as conduction line.	Same as conduction line.	
Existing distribution line	Same as conduction line.	Same as conduction line.	

2.4.2 Required Organization for O & M of the Project Facilities

As shown in Table 2.26, new operators will be required for O & M of the WTPs while the water source wells, conduction lines and distribution mains to be constructed by the project can be operated by the existing organization.

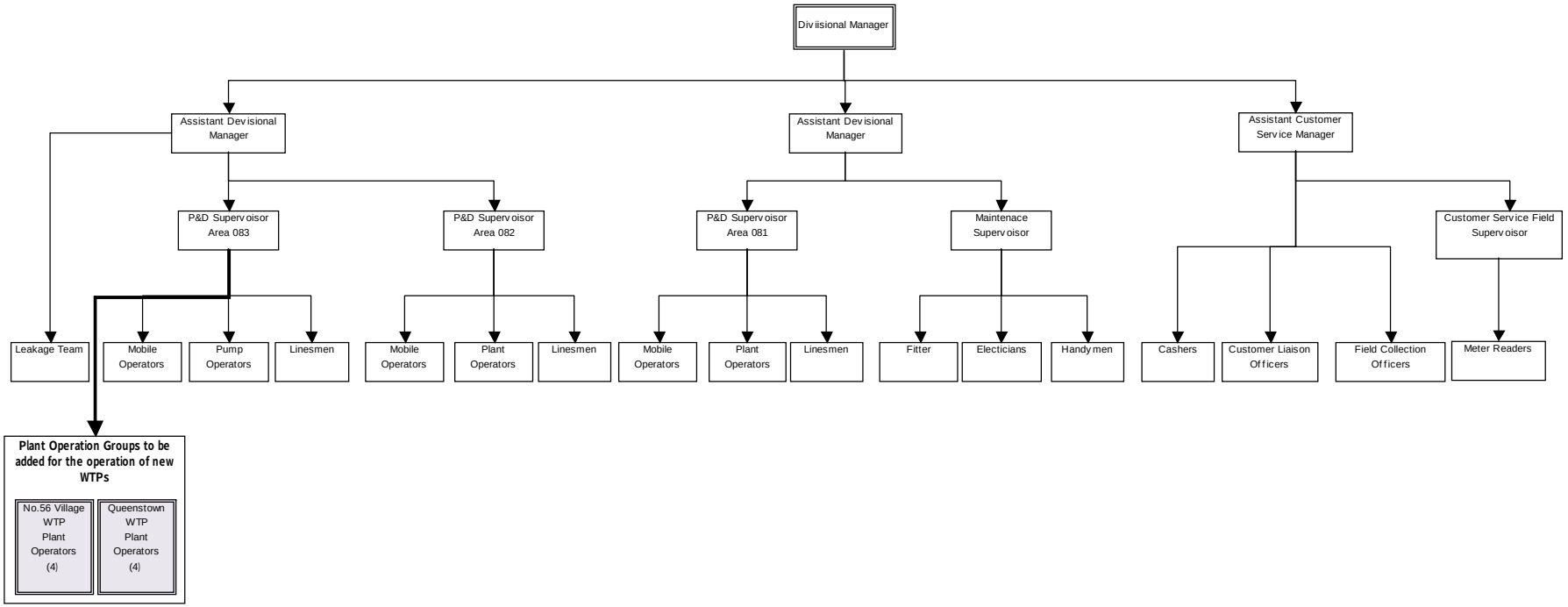
The new plant operators shall be familiarized with the operation of the slow sand filtration. Since the operation of sand filters are not so sophisticated and not requiring special skills, operational skills can be transferred by the soft component of the project.

Organizational structure of Division 5 will be changed as shown in Figure 2.8, by adding two plant operator groups under the P&D Supervisor of Area 083.

2.4.3 O & M of Water Supply Services in the Project Area

As mentioned in Design Policy of this Report, the project is based on the premise that the non-revenue water control (leakage control programs, introduction of meter based tariff, etc.) will have been executed and the leakage ratio will reduce to 25%. Therefore, O & M measures related to the reduction of the leakage and non revenue water as shown below are required to be implemented substantially:

Installation of Water Meter: It is required all the water meter procured in the project are installed by the completion of the project.



Source: Hearing from GWI Division 5. Organization as per November 2005.

Figure 2.8 Present Organization of GWI Division 5 and Groups to be Added for the Operation of Project Facilities

Tariff Collection: Following the installation of the water meters, it is required to apply metered rate to all the customers and to develop an organization capable to read the meter, to submit the bills and to collect the tariff orderly. It may be helped by the water tariff system survey currently GWI intends.

Leakage Management: It is required to fully organize leakage monitor and leakage repair teams to minimize water loss by leakage. Current GWI's leakage control strategy shall be continued and enhanced.

2.5 Project Cost

2.5.1 Component Covered by Japan

The total project cost which will be required for implementing the project under the grant aid scheme of Japan is estimated to be 1,363 million Japanese Yen.

(1) Estimated Costs Covered by Japanese Side

The estimated project costs beard by the Japanese side in accordance with the scope of work described in Implementation Plan in this chapter is approximately 1,346 million Japanese Yen, of which breakdown is given in Table 2.27. However, the estimated cost does not mean the grant amount to be described in the official Exchange of Notes between both governments.

Table 2.27 Cost Covered by Japanese Side

Expense Item			Approximate Cost (million Japanese Yen)		
Facility	Rehabilitation of Existing Wells	Emergency Generators, Well Pumps	54.8	1,134.5	1,208.5
	Construction of Water Treatment Plants	Slow Sand Filters, Storage Reservoirs, Elevated Tanks, Chlorinators, Lift Pumps	875.2		
	Installation of Conduction and Distribution Main Pipe Lines	Excavation, Pipe Laying, Back Filling, Repavement	204.5		
Equipment and Material	Water Meters	Water Meters, Accessories, Meter Boxes	74.0	74.0	
Detail Design・Supervision of Construction					137.3
Approximate Project Costs					1,345.8

(Phase 1: 637.1 Million Japanese Yen, Phase 2：708.7 Million Japanese Yen)

This cost estimate is provisional and would be further examined by the Government of Japan for approval of the Grant.

(2) Costs Covered by Guyanese Side

Scope of work covered by the Guyanese side are shown in Table 2.28 together with the required costs. Among the scope covered by the Guyanese side, most of scope dose not cost the Guyanese side since all the required sites are already in possession of the Ministry of Housing and Water and most of works can be done by GWI's operators as their daily work. Only costs required for the installation of power lines to the facilities sites and the installation of water

meters will be borne by the Guyanese side.

(3) Conditions of Costs Estimate

<Time of Estimate>

The exchange rates applied are based on the average rates from June 2005 to November2005.

<Exchange Rates>

The exchange rates applied are as follows:

- 1 USD = 113.53 Japanese Yen
- 1 GYD = 0.58 Japanese Yen

Table 2.28 Scope of Work of the Guyanese Side and Their Required Costs

Scope	Costs (Million Japanese Yen)	Remarks
(1) Securement of temporary work sites	-	Owned by Ministry of Housing and Water
(2) Securement of WTP sites	-	Owned by Ministry of Housing and Water
(3) Cutting over the Queenstown WTP	-	GUYSUCO
(4) Arrangement of	-	Will be dine by Mobile operators or Linesmen
(5) Securement of space for emergency generators and fuel storage tanks	-	Enough space in the existing well sites
(7) Information of underground structures and presence at the excavation	-	Will be dne by Mobile operators or Linesmen
(8) Presence at and announcement of the connection of new distribution main and existing distribution trunk	-	Will be done by Mobile operators or Linesmen
(9) Provision of water for pipe washing and pressure test	-	GWI's water
(10) Coordination at chlorine disinfection of new pipe lines	-	Will be done by Linesmen
(11) Installation of electric power line to the facility site	2.292	Contract to GPL
(17) Installation of water meters	14.482	Subcontractors
合計	16.774	

2.5.2 Operation and Maintenance Costs

(1) Production Costs

In the calculation of the production costs, following costs are added up:

- ✓ Manpower
- ✓ Electricity
- ✓ Chemicals
- ✓ Repairing
- ✓ Depreciation

Results are shown in Table 2.29.

Table 2.29 Production Costs

(1000 GYD/year)

Case	Manpower[1)]	Electricity[2)]	Chemicals[3)]	Repair[4)]	Depreciation[5)]	Total ( ): not including depreciation
Leakage control is achieved at the completion of the project	9,881	52,540	862	2,000	40,000	105,283 (65,283)
Leakage control is not achieved at the completion of the project. It requires operation of existing wells	9,881	79,871	862	2,000	40,000	132,614 (92,614)

1): Manpower cost is calculated from cost for additional 8 operators (Grade DS1, salary 35,470 GYD/month: total: 3,405,120 GYD/year) for new WTPs and allocation of the present total manpower costs (estimated at 26,983,632 GYD/year) of Division 5 to the project area.
2): Calculated from operation length and power of each pump.
3) Cost of chlorine for disinfection.
4): Assuming 1% of the total equipment cost of the project (200 million GYD)
5): Straight line method; Asset value ;2,200 million GYD (Project cost – Engineering cost), Residual value; 10%, depreciation period; 50 years.

(2) Revenue

In the project site, 9.5% of customers have water meters, no metered rate, however, is applied but only the fixed rate is applied[11]. Since water revenue specifically in the project area is not available, present revenue for the project area was estimated as shown in Table 2.30.

Table 2.30 Estimated Revenue in the Project Area

Category of Customers*		Number of Customers**	Fixed Water Rates (GYD/Year) *	Revenue (GYD/Year)
Small business		1,454	25,440	36,989,760
Residents	Low income (less than 60,000GYD/month)	4,509	4,500	20,290,500
	High income (more than or equal to 60,000GYD/month)	1,199	14,400	17,265,600
Total		7,162		74,545,860

*: From tariff table of GWI
**: Based on the social survey conducted in the Study. Self owned business and others in the categories of the survey are considered to be "Small Business" and "Resident" in the GWI's tariff table, respectively.

Meanwhile there is a metered rate, although it is not applied in the project area. Supposing the metered rate is applied to all the costumers in the project area, revenue to be earned is calculated. In the calculation, the metered rate of 58 GYD/m^3 is applied and water consumption by each customer is presumed 135 l/capita/day (subtracting 25% of leakage loss from 180 l/capita/day).

31,643(population in 2005) x 0.135 l/capita/day x 58GYD/m^3 x 365days＝90,434,111GYD/year

GWI is now requesting the tariff increase by 10%. If it is approved, revenues of 82,000 thousand GYD/year by the fixed rate and 99,000thousand GYD/year are expected.

[11] Hearing from GWI Division 5.

(3) Cost and Revenue Balance

Comparison of the estimated production costs and revenues is shown in Table 2.31.

In case where the leakage control is achieved and 10% tariff increase is approved, the revenue slightly lowers the production cost with depreciation. However, as the asset value is possibly overestimated in the calculation of the depreciation, actual depreciation rate may be smaller than it. It can be therefore judged that the revenue covers the production cost. Since ratio of the depreciation to the total production cost is as high as 25%, the production cost may be covered by the revenue without 10% increase depending on the asset value evaluation.

In case where the leakage control is not achieved and the pump operation of wells other than water resource wells of WTPs is continued, the production cost far exceeds the revenue because of high electricity cost.

Early achievement of the leakage control is desperately required from a view point of sound financial balance, too.

Table 2.31 Comparison of Production Costs and Revenues

Revenue (1000GYD/year)		Production Costs (1000GYD/year)		
By metered rate	90,434	Leakage control is achieved at the completion of the project	Including depreciation	105,283
			Excluding depreciation	65,283
By metered rate after 10% tariff increase	99,000	Leakage control is achieved at the completion of the project	Including depreciation	132,614
			Excluding depreciation	92,614

(4) Customer's Affordability

According to the results of the social survey, respondents showed the willingness-to-pay 10 % more than the present payment on the average on condition that the service quality is improved.

Supposing that 10% tariff increase is approved and the metered rate are applied to all the customers, the water tariff of the average family (4.1 persons per family) is 1,059 GYD/month. Average family income in the project area is estimated at 42,700 GYD/month (Median=39.000 GYD/month) by the social survey, which equivalent to 2.5 % of the average monthly income. Therefore, it can be considered to be affordable in general.

2.6 Items to be Considered in Implementing the Project

(1) Early Commencement of WTP Site Preparation Work

There are major rainy season around May and June and minor rainy season from November to March in the Project area. Even between the rainy seasons there are occasional rainfalls. It is practically difficult to set up a work period out of the rainy seasons. Therefore, the site preparation work which is strongly affected by rainfall is set up out of the rainy seasons and other works are executed during the rainy seasons.

Under the planned schedule, to complete the site preparation before the major rainy season, the

site preparation shall be completed within two months. To enable it, Guyanese side is required to obtain all the permits necessary for the implementation of the work and to install the temporally electric power line during the mobilization period.

Although there would be no particular problems in negotiation with related organizations and persons since the sites are already under competence of the Ministry of Housing and Water, it is recommended to be beforehand with formality required in the various stage of the project.

Negotiation between GWI and GPL regarding the installation of the power line has been undergoing. It would be more desirable if the power line is installed before the commencement of the project without installing the temporally power line.

(2) Securement of WTP Operators

It is required to assign 4 operators of No.56 Village WTP before the completion of the 1st phase of the project and 4 operators of Queenstown WTP before the completion of 2nd phase. The operators of No.56 Village WTP are an intended target group of the soft component of the project (software assistant).

(3) Installation of Water Meters

It is required to install all the water meters procured by the project before the completion of the Project. The Project can achieve the expected effects only when leakage is controlled by the water meters and the metered water tariff.

Therefore, Guyanese side is required to establish an organization to enable the early installation of the water meters.

(4) Special Consideration to Residents in Corriverton Urban Area

In general, effects of the Project works to the residents are expected to be a very limited degree because major facilities of the Project are installed in the areas way off from residential areas and pipes are installed along the roads not busy. However, in the Corriverton area, residences and small business houses stand side by side along the road using road shoulder as trading place and parking place. Therefore, the pipe installation work in this area could cause negative impacts to their commercial activities. While the work will be carried out by dividing the section into a short piece in which all the works can be completed within one day to minimize the negative impacts, cooperation of the residents is inevitable. The Guyanese side is required to take necessary actions to inform the residents of purpose and components of the Project and work schedule, so that the residents become cooperative.