

CHAPTER 8 ORGANIZATION & INSTITUTION FOR OPERATION, MANAGEMENT AND MAINTENANCE

8.1 Current Situation of Organization & Institution for Operation, Management and Maintenance (O, M & M) of Water Supply Sector

Among the Study Areas of 8 Towns, the water supply systems at two Provincial Towns of Daru and Popondetta are already included in the PNGWB's management and it will be all right in principle if the present organization & institution for operation, management and maintenance (O, M & M) are sustained. However, the cost exceeds the revenue and making losses for both cases of Daru and Popondetta. Salary of the staff is the biggest item among the expenditure items. Especially the operators in Daru are too many and review of the organization is required. As it is described later, the Customer Services Division, the division in charge of the O, M & M in the PNGWB, is urging renovation of organization and institution that must be effective for improvement of the service and business efficiency. It is assumed that rationalization of the organization and institution such as cutting the number of staff will be done in the two Provincial Town water supplies that are not making profit. In fact in case of Daru, it is scheduled to introduce a new scheme where the water district will be under management of the Southern Region Office, and so no District Manager will be appointed and the Regional Manager will have direct control. This is expected to give a cost reduction.

8.2 PNGWB's Organizational Reform

PNGWB is proceeding its reorganization and reformation apart from this Study. As part of this reorganization/reformation, its Customer Services Division, which is the centre for O, M & M, has introduced a new structure recently (refer to Fig.-8.1). New structure divides the entire work zone of PNGWB into three regions and each region is managed by respective Regional Office. It is expected that this will contribute to realize more efficient management of each water district, especially in small Water Districts. The entire country was divided into Northern Region, Highlands Region, Southern Region, and the regional offices are established at Lae, Mt. Hagen, and Port Moresby, respectively. The following table shows the coverage of each Regional Office.

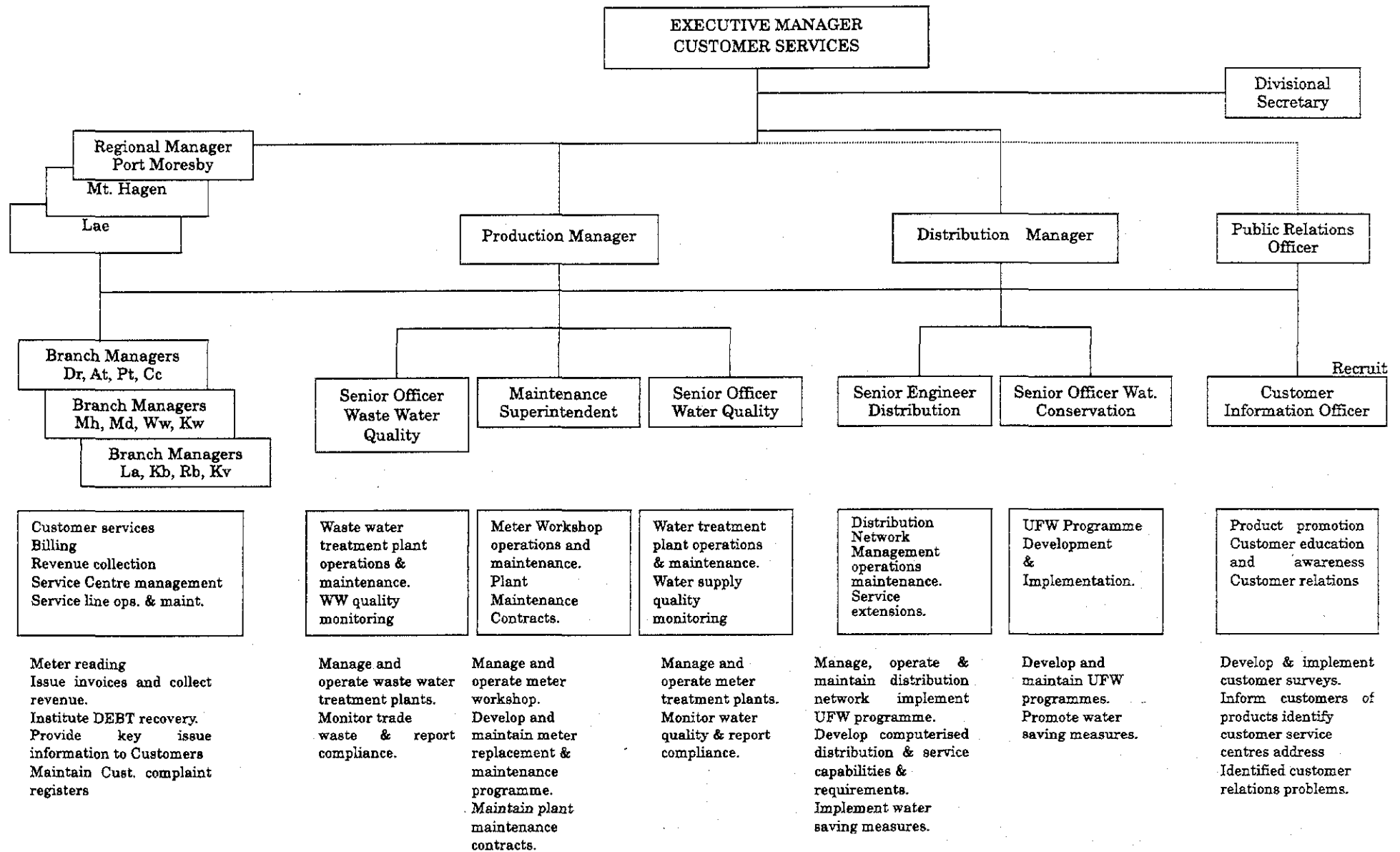


Fig.-8.1 Organization Chart of PNGWB Customer Services Division

Table-8.1 PNGWB New Organization of Regional Office

Region	Regional Office	Water District (WD) to be managed *WD in bracket (): projection stage	Current Situation
Northern	Lae	Lae, Kimbe, Rabaul, Kavieng, (Lorengau)	Office: Established in early June, 2001 Manager: Appointed.
Highland	Mt.Hagen	Mt.Hagen, Madang, Wewak, Kundiawa, (Mendi, Wabag)	Office: Established in early June, 2001 Manager: Appointed.
Southern	Port Moresby	Daru, Alotau, Popondetta, (Central City, Kerema)	Office: Established in early June 2001 Manager: To be appointed soon.

*Central City is a Provincial Town of Central Province under construction.

These three Regional Office have been established and the managers for Northern Region and for Highland Region were appointed while one for Southern Region is in the process of recruitment. It is expected that the regionally decentralized management system utilizing Regional Offices improves the efficiency of operation. At the same time, as a result of this reformation of Customer Services Division, positions of Production Manager (stationed at Madang) and Distribution Manager (stationed at Lae) are set up and these managers have been appointed. The Production Manager is responsible for water production in the entire country and the Distribution Manager is responsible for entire distribution. Their grades in the PNGWB are the same as that for Regional Managers (Grade 14). It is presumed that if managerial staff is reduced at the water districts like Daru where constant deficit is made, Regional Office may directly manage and contribute to reduce the shortfall. This concept can be adopted also to the management of water supply services at District Centres.

Another reformation under consideration is attachment of Public Relations Officer under Executive Manager Customer Services from Corporate Relations Division. This concept should be urged because this attachment of Public Relations Officer to the Customer Services may contribute to activate communications with the water users while such communications are lacking currently. It is observed that the engineering viewpoint has been dominant in the organization as it is important when Technical Services Division promotes new construction and upgrading of the facilities, and Customer Services Division operates and maintains the facilities. However, for the actual improvement of water supply services, communications with the water users are also indispensable

to encourage proper use of water supply facility, to achieve satisfaction of the users and to let the users pay smoothly. Especially for District Centre water supply, this aspect of communication with the users must be essential and it is recommended that PNGWB strengthen this function. Further, more training programs on communications and customer relations should be included in the existent training programs to the staff of PNGWB that currently cover mainly technical knowledge and skills only.

8.3 Analysis on Organizations & Institution for Operation, Management and Maintenance

On the other hand, it is obvious that the sizes of population of these 6 District Towns are small and the Water Districts would not be able to earn enough revenue for proper O, M & M, and it is essential to set up the framework of financial support to the Water Districts of the PNGWB. In case of the 3 District Towns of Bereina, Kwikila and Mutzing where the Pilot Project was implemented, the declaration of new Water Districts was done by the minister, and the O, M & M is under the PNGWB. In order to minimize the O, M & M cost only a water operator and the assistant are stationed in the Water District and the management of the Water Districts is done by the Regional Managers of Southern Regional Office for Bereina and Kwikila and of Northern Regional Office for Mutzing. Therefore, when improvement of water supply systems in the other District Towns, i.e. Finschhafen, Oro Bay and Kupiano are realized, Finschhafen will be managed by the Northern Regional Office at Lae, Kupiano by the Southern Regional Office. In case of Oro Bay the management by the Branch Office at Popondetta will be realistic.

Concerning the District Towns where the Pilot Project was implemented, the minutes of understanding on implementation of the Pilot Project (MOU) and the minutes of agreement on the O, M & M of the water supply systems (MOA) were made between the PNGWB and the respective Provincial Government and the Local-level Government. The functions of both parties agreed in the MOA are described as below.

a) Function of PNGWB

PNGWB is the owner of the water supply systems in the Water District and in charge of the O, M & M. When the NWSS Act was enforced the water supply systems of the Provincial Towns were transferred from the DoW to the PNGWB, and the Water Districts were declared by the minister. At the same time the ownership of the facility was handed to the PNGWB, and the O, M & M has been done by the PNGWB. On the other hand, in case of the District Towns the ownership shall be transferred to the PNGWB from DoW or the Provincial Government when the Water District is

declared. Similarly, the entire process of the comprehensive O, M & M of the water supply services including operation of the facilities, water fee collection, inspection and repair, shall be the responsibility of the PNGWB after the transfer. Moreover, when the facilities require renovation and/or extension, funds for the capital investment shall be secured also by the PNGWB. In case of the facilities renovated by the pilot project, installation of water meters for individual connections is necessary and the PNGWB is doing this.

b) Function of Provincial Government & Local-Level Government

Function of Provincial Government and Local-Level Government regarding water supply services of District Towns is to support the PNGWB's routine activities in the Water District and a Consultation Meeting with the PNGWB shall be held at a minimum of once a year to discuss the issues and to find the solution. The most important point is that Provincial Government and Local-Level Government are in a position to compensate to the PNGWB by providing the subsidy when the deficit is made in the operation of these Water Districts. Amount of the subsidy shall be decided in the above-mentioned Consultation Meeting. This function of Provincial Government and Local-Level Government is proposed in order to facilitate the PNGWB's extension of their services into the District Towns where the deficit in the operation is anticipated, and this kind of function is not required in case of the water supply services in the Provincial Towns.

8.4 Operation, Management & Maintenance Scheme

1) Establishment of O, M & M Scheme for Water Supply Services in the Study Area

a) Management by PG & LLGs and Their Constraints

PNGWB has been trying to extend its water supply and sanitation service in Provincial Towns entirely under current situations as mentioned above. The Study Area includes two Provincial Towns that PNGWB has been managing and 6 District Towns that are the target for the future.

District Administration is in charge of management of water supply service at 6 District Towns of the Study Area except Oro Bay that does not have any facilities. There are District Towns such as Finschhafen and Mutzing that are supplying water though it is insufficient. On the other hand, there are District Towns where the water supply has stopped for a long period as it is in Kwikila, Kupiano, and Bereina.

“Water Supply Service” had been provided free of cost to the people by the Government before NWSS Act was enacted. Operation & management of water supply service of District Town

were transferred from Dept. of Works (DOW) to PG & LLG. Originally, the water supply facility of District Town was constructed for only "Station" which was the base of the administrative service of Provincial Government (PG) at the district level. In majority of the Stations, water supply are provided while the minimum level of the additional investment and repairs which are required for operation of the facility built during the DOW period. However, because the fee collection for the water supply service is not practised at all, the cost is mainly borne by PG & LLG.

In case of Kwikila and Kupiano after the breakdown of the facility and the equipment the water supply service stopped, and the systems remain unused while the budget preparation for repair/replacement of the equipment was not done by the Provincial Administration. Although there must be efforts of PG & LLGs to improve the situation, their financial, human and organizational resources required for water supply improvement are insufficient, and the water supply stops continuously. Moreover, the existing facility often include incompleteness and defective construction. of the plan, the design and/or the construction. These show the necessity of the provision of the service by the organization that is well versed in the water supply service.

In Finschhafen and Mutzing, the enhancing construction and the maintenance and management. have been done by using the budget of the PG & LLGs. Therefore, the water supply is maintained more or less constantly. However, because the facility is becoming old, stable water supply service is vulnerable. The operator who belongs to DOW is allocated for operation of the water supply system of District Town. However, their roles are limited to doing the operation of existing facilities and minimum maintenance due to budget shortage. The fee collection is not done. Anything is hardly performed for basic management. It is curious that dissatisfaction of the residents do not confront the authority even if the water supply has stopped. It is thought that the reason for this is that most of residents can use the water of the rain water collected as an alternative source.

"Commitment", "High Motivation", and "Resources" are necessary to do a consistent water supply service management as the implementing organization. All of these are insufficient for PG & LLGs concerning current District Town water supply service. The workshop was held in Port Moresby for the staff of PNGWB on the 19th and 21st of August 2000. Moreover, the representatives of relevant organizations on the national and local levels and in the water supply sector participated in the workshop which was held in Kwikila on the 23rd and August 24th, 2000. Similar problems as mentioned-above were pointed out in these workshops. Therefore,

it is assumed that it is difficult for PG & LLGs to achieve the management of water supply service.

b) Consideration for Low Income Group and Promotion for Water Supply Coverage in Village

i) Water Supply to Low Income Group in The Urban Area

In two Provincial Towns of the Study Area, Popondetta and Daru, settlements for low income groups among the residential areas exist. Especially, it is obvious in Daru. The water supply is available even in the area where low income group lives and many of the residents in such areas have water connection. However, many of these residents fail to pay for water charge in time. When they do not pay for three months these customers are disconnected by PNGWB. The unpaid bill amount and reconnection fee must be paid to restore water supply. There are many residents who gave up to reconnect because they could not pay. Since they could not get water supply service they use water from the shallow well where most shallow wells have the problem of water quality, volume and seasonal instability. Such a situation is common and seen in most Provincial Towns. PNGWB has been trying to mitigate the problem that questions on how to balance promotion for water supply coverage and cost recovery. Although trial and error such as introduction of flat rate for the users of the public faucet, etc. have been done by PNGWB, but a concrete evaluation has not been practically done yet.

It is proposed in this Study to try the water vendor method as follows that have been introduced under similar environments in other countries.

- PNGWB sets up the public faucet for this trial in the target area.
- PNGWB contracts Water Vendors and appoints them as “Water Distribution Agents” and. In that case, certain amount of money is deposited by “Water Distribution Agents” to PNGWB.
- The Water Distribution Agent sells water to users by certain unit of water such as bucket or tank at the above-mentioned public faucet. In this case, the water price by Water Distribution Agent shall be within the range that PNGWB admits.
- The residents pays water charge to the Water Distribution Agent whenever water is drawn from the public faucet, and the Water Distribution Agent pays PNGWB the water charge by measuring the meter installed at the public faucet.

It seems that a similar experiment was not carried out in PNG. Therefore, it is proposed to have this experimental introduction of the system to confirm its adaptability in PNG, and especially as the Pilot Project of which implementation during the “Study in PNG 2” is recommended. If the adaptability is confirmed, this method can be applied to other towns.

Eda Ranu that is in charge of water supply in NCD has a large area where fee collection is not made and it is a considerable issue for them. Eda Ranu also has a plan as follows for the Pilot Project in a part of the settlement in Port Moresby from December 2000.

- Communal tap shared by about four households is set up by Eda Ranu.
- The residents establish water committee. This water committee makes a contract with Eda Ranu, and the charges are collected from the residents.
- Water committee pays Eda Ranu water charge (flat rate) for communal tap.

ii) Water Supply to Village Residents

There are some cases where the water sources for water supply service of Provincial Towns and District Town are not available within the Town boundary, and the proposed water source point is located in the customary-land which is traditionally owned by village residents. In such a case, the village residents very often are also facing shortage of drinking water and willing to receive the water supply service. Provision of water supply service to the village residents may be one of the key issues to get the consent from them concerning use of water source.

In case of the water intake for Daru water supply at Binaturi River, this water source is very essential for the water supply in Daru. There are several villages along the river and the residents do not have water supply facility and there is drinking water shortage. Among them some demand large amount of money as compensation from PG & LLG and PNGWB for the water intake, and sometimes obstruct the operation of water-intake. Such residents are frustrated because no improvement was made for their water supply and hoping to have water supply facility. The demand for water supply service may be one motivation of their behaviour other than economic reasons. Therefore, it is necessary to examine the demand and feasibility of water supply to these village residents related to the water source use during the water supply plan stage. In case of the villages along Binaturi River, independent and simple water supply facilities such as rain water tank and shallow well are appropriate since the villages are located far from the water supply system and the population is not large.

On the other hand, it is common that residents of the villages that locate adjacent to the District Town hope to receive the water supply service. This is also an issue to be considered and the village residents shall be covered by the water supply service when the conditions such as enough capacity of water source, appropriate distance of pipeline to the village, the villagers' preparedness for cost bearing are satisfactory.

When most of the District Towns are covered with appropriate water supply system in the future,

the water supply improvement of the villages that are outside of the District Towns will become another task to be tackled by PNGWB. The construction and/or improvement of the facilities and sustainable O, M & M for these areas will be more difficult than the case of District Towns. However, there is no organization that is in a position to solve this problem other than PNGWB as CSA under NWSS Act. The Study Team made a presentation concerning the proposed participation of PNGWB in District Town water supply service to the executives (Water Executive Team: WET) of PNGWB on September 1, 2000. WET of PNGWB showed their interest and understanding to the concept explained by the Study Team, and explanation by WET to the Board on this issue is scheduled. Moreover, although it is still at the level of idea, setting up a specialized division or separate organization such as Non-Profit Organization apart from the basic framework of PNGWB for the particular task to work on District Town and rural water supply services which are not on commercial basis at the moment is under consideration at the management level of PNGWB.

2) Support for O, M & M Scheme (Possibility of Subsidy Provision)

Institution and management of water supply system for the District Towns and concrete measures of support are considered as follows.

If it is assumed that District Town water supply service continuously make a large amount of deficit and such a loss has to be absorbed by PNGWB, PNGWB cannot undertake the O, M & M. Therefore, it is necessary to take measures that make PNGWB free from such financial burden. The possible approaches are: i) to increase the revenue, ii) to get financial support of the government, iii) to reduce expenses. These concrete measures are proposed as follows.

a) Establishment of Trust Fund by Grant from Rural Development Fund

Rural Development Fund is a fund to appropriate the government capital directly to the investment of development in rural areas. The population of the rural area is counted approximately 85% of the entire population of the country and economic and social infrastructures in the rural areas are still at very limited level. The improvement of the living standard in the rural areas is strongly requested by the residents. However, the administrative system, where PG&LLG are commanded by the central government and its financial flow from the central to the rural area goes through bureaucratic steps, has not been able to achieve high performance for the improvement of the living conditions of the people in rural areas. In that sense, Rural Development Fund is an alternative flow of the government budget for this particular purpose. The budget is allocated in District Development Program (DDP) through

Office of Rural Development (ORD). In 2000 fiscal year the budget of K143.5 million in total is allocated and divided into the following several kinds of grant as shown in Table-8.2.

The proposed measure to utilize the Rural Development Fund is part of the Social and Rural Development Grant (S & RDG) allocated to establish a trust fund to support the management capital of District Town water supply service in the concerned districts. The amount of deficit caused as the balance between income and expenditure will be funded from the trust fund as the supplementary funding. Among the various types of the grant of the Rural Development Fund, S & RDG is assumed as an appropriate grant for the purpose. Although S & RDG is mainly allotted for capital investment, this trust fund is to mortgage the management of District Town Water Supply Service that is an important infrastructure investment. Therefore, allocation of this grant for the establishment of the trust fund is considered eligible. It is indispensable that the plan of establishment and management of the trust fund shall be contained in the District Development Plan with the endorsement of Joint development Planning & Budget Prioritisation Committee (JDP & BPC). Therefore, it is necessary to confer sufficiently with the related organizations.

Table-8.2 Trust Fund by Grant from Rural Development Fund, 2000

Type Of Grant	District Support Grant (DSG)		Provincial Support Grant (PSG)		Social and Rural Development Grant (S&RDG)
Recipient Of Grant	89 Open members of the national parliament (Member)		Provincial member of The national parliament (Member)		89 Districts
Amount of Grant	K50 million per Member		K50 million Per Member		K1 million per District
Sub-Type Of Grant	Discretionary	Non Discretionary	Discretionary	Non Discretionary	N. A.
Amount of Grant	K25 million	K25 million	K25 million	K25 million	N. A.
Decision -Maker on Utilization	Member	JDP&BPC	Member	JDP&BPC	JDP&BPC For endorsement

*JDP&BPC: Joint Development Planning & Budget Prioritisation Committee

b) Supplementary Funding from Budget of PG&LLG

There is a budget which PG & LLG has expended for the existing system for water supply service. The equivalent budget can be offered as supplementary funding to absorb the deficit of O, M & M for district water supply service, and PG & LLG will agree to allocate the budget for this funding if the partnership agreement is made between PG & LLG and PNGWB. On the

other hand, however, PG & LLG are not recognizing accurately the actual financial position of water supply services in District Towns. It is essential that PNGWB secures the transparency of the financial positions of each District Town water supply service, and must be ready for the accountability. The anxiety of this approach is unstable cash flow of the national government that disburses the fund to PG & LLG. In recent years this delay of disbursement of the budget has been affecting the work of PG & LLG considerably. When the disbursement delays excessively or becomes unexecuted, this approach will not contribute to support PNGWB.

c) Establishment of Maintenance Support Base

In O, M & M of water supply system, there are technical aspects such as operation and maintenance of the facility and equipment, and managerial aspects such as billing, fee collections and administrative matters. Certain resources for O, M & M such as staff, facilities, equipment, are not used everyday but required regardless of the scale of the water supply system. Such required resources may become a heavy burden for District Town water supply. If District Towns can share such resources as much as possible, the load can be reduced. The maintenance support base is that common O, M & M resources are available and can be used by two or more District Town water supply services. As a result, reduction of the total expenditure for this kind of resources in these District Town water supply services may be achieved.

It is realistic that the maintenance support base is set up within the existing Water District Office of PNGWB. The maintenance support base shall secure the required capacity of human resources to support District Town water supply services with easily accessible geographical conditions as well as the facility and the equipment for repair, inspection, training, accounting, etc. Especially, in case of district centres which are located in the area where the existing Water District Office does not exist, the set-up of this kind of maintenance support base is strongly recommended. For setting up this kind of facility funding by the government and/or the foreign aid shall be considered to reduce the load of PNGWB.

3) O, M & M Plan

The following measures for solution of the problems are considered. The water supply in District Town is not well managed due to problems in "Facility", "Institutional framework (including human resources)", and "Financial Affairs". The following solutions are discussed.

- i) The facility: The most appropriate plan, design and construction should be implemented.
- ii) The institutional framework: The institutional framework which has the capability to

respond to the issues on both technical aspect and managerial aspect should be established.

- iii) Financial affairs: It is necessary to establish the fee collection as the cost sharing by users and the independent accounting of water supply service. Subsidy allocation from the Governmental budget to compensate the loss caused by insufficient revenue should be possible.

The human resources competent in the technical aspect and the managerial aspect, and the institutional framework which can offer them enough knowledge and experiences are required to manage water supply service of District Town. The following Table-8.3 shows the comparison of evaluation of readiness of respective organization as a candidate for the management.

Tbale-8.3 The Comparison of Evaluation of Readiness of Respective Organization

Name of Organization Evaluated	Technical Aspect (Human Resources/ Knowledge & Experiences)	Managerial Aspect (Human Resources/ Knowledge & Experiences)	Feasibility to be a Responsible Organization for the Management
Provincial Government	Difficult	Difficult	Low
District Administration	Difficult	Difficult	Low
Local Level Government	Difficult	Difficult	Low
Dept. of Works	Available	Difficult	Low
PNG Waterboard (PNGWB)	Available	Available	High
Private enterprise	Available	Available	Low

During this Study, hearings, discussions, and information and data collection from the relevant organizations such as PNGWB, central governmental agencies, and PG & LLGs were made. Only PNGWB and private enterprises have capacity to provide the human resources and knowledge on technology and management. However, private enterprises cannot provide services due to the limited commercial viability of water supply service in District Town while PNGWB's case has feasibility.

The following two methods are possible when PNGWB's participation to the water supply service in District Town is discussed. One method is direct operation & management by PNGWB, and another one is called "External Services" in which PNGWB provides the technical service to PG&LLG who is in charge for the management of the water supply service. These are explained as follows.

- a) Direct operation & management by PNGWB and declaration of new Water District

Direct operation & management by PNGWB is an alternative in which PNGWB takes charge of operation, maintenance & management (O, M & M) of the water supply service directly as same as is of Provincial Towns where currently O, M & M is done by PNGWB. For this method a new water district for each District Town under NWSS Act shall be set up so that PNGWB will become solely responsible for the O, M & M of District Town water supply service. Meantime the support by PG & LLG to PNGWB for the O, M & M shall be there. The following processes are necessary for this.

Setting up (declaration) of a new Water District:

- PNGWB confers and agrees with the relevant PG&LLG concerning the partnership agreement.
- The Board of PNGWB recommends the minister the declaration of a new Water District.
- The Minister (currently Minister for Privatisation and Corporatisation) declares the Water District under NWSS Act.

When the new Water District is set up for water supply service of the District Town, the management system for the new Water District basically follows the one applied for Provincial Town currently. This shall be an integrated management of different (smaller) business scale, and include the following essential items:

- Operation of water supply service meeting the standard in water quality, volume of water, hydraulic pressure, etc.
- Maintenance, service, repair, expansion
- Billing, fee collection, procurement, public relations, and other management issues

In comparison to the number of customers among 11 Provincial Towns under PNGWB, Kundiawa having approximately 600 customers is the smallest. Daru which shows the biggest loss among 11 Provincial Towns has 1,100 customers. Most of 6 District Towns under the Study can expect customers less than 200. Therefore, the following conditions are required for this kind of small-scale water supply system.

- i) Design and construction of low-cost and efficient facility
- ii) Low-cost management system

However, the income of the District Town water supply with 200 customers is assumed to be absolutely insufficient. Therefore, a mechanism that PG & LLG bridge over the financial gap is assumed indispensable.

- b) External Service by PNGWB

External Service is a method in which PNGWB provides only the technical services (operation and maintenance, regular service, etc.) to PG & LLG. In this case, the management of water supply service is conducted continuously under PG & LLG. PNGWB is providing this external service currently in Lihir, New Ireland Province, to respond to the request of the mining company (Angoram) by the request of the East Sepik state, and Kokopo for the public utilities such as high school, located outside of Rabaul Water District in Eastern New Britain Province. The condition and the charge for the external service is concluded in the agreement between PNGWB and the respective PG & LLG. For example, in case of Angoram, East Sepik Province, PNGWB and the Provincial Government are arranging either of each Operator and the assistant.

The managerial aspect such as fee collections in these water supply service shall be taken care by PG & LLG. Therefore, PNGWB does not know the actual position of balance between the fee collected and the cost. It is assumed that there are cases in which the PG & LLG are not collecting water fee for the water service in spite of the national water policy "USER PAY POLICY", and other cases where large amount of financial deficit is generated. In fact there are cases where PG & LLG fails to pay the external services fee to PNGWB. Therefore, it is assumed that only in case of the water supply service of which cost of O,M&M is low and/or certain level of revenue is expected, the external service method is applicable for District Water supply. However, the number of such District Town must be very limited.

CHAPTER 9 COST ESTIMATION

9.1 Cost Estimation

1) Cost Estimation

The cost estimation of the water supply systems at 6 District Towns in the master plan is shown in Table-9.1 below. The execution time of cost estimation is December 2000. The exchange rate is 1Kina=Aus\$0.5955, 1 Aus\$=¥58.6 1Kina=¥34.9 and 1US\$=¥120. Moreover, neither domestic tax nor other collection of taxes, the value added tax, etc. of PNG are included in this estimation.

Table-9.1 Cost Estimation of 6 District Town Water Supply Systems

Study Area	Construction Cost (Kina)			
	Stage- I	Stage- II	Stage-III	Total
1) Bereina	1,495,600	891,700	617,600	Kina 3,004,900
2) Kupiano	3,457,100	2,704,800	3,307,100	Kina 9,469,000
3) Kwikila	1,565,600	1,325,300	735,500	Kina 3,626,400
4) Finschhafen	1,985,400	1,585,800	2,282,100	Kina 5,853,300
5) Mutzing	823,500	519,900	-	Kina 1,343,400
6) Oro Bay	2,119,700	2,740,400	1,315,000	Kina 6,175,100

2) Land Procurement Cost and Compensation

There is a historical background peculiar to this country for the land problem of Papua New Guinea. For instance, the case with the existence of two or more landowners of the same land is not rare. The confirmation and acquisition of the facilities construction sites are difficult. In the selection of the facilities construction site for this plan, State Land (public property) is a precondition of the candidate. Customary Land (private property) is off the subject. Therefore, neither the land procurement cost nor the compensation for the facilities construction site is included in this estimation of above-mentioned.

3) Operation and Maintenance Costs

Basically, the income from water service charges becomes the only fund for the operation and maintenance of the water supply system. It is difficult to formally start the collection of water charges immediately after the completion of the water supply system. Therefore, a fixed

charge will be collected during the shift period until the metered charge collection system is formally established. In the calculation of the operation and maintenance cost, the details were divided into five items including the power expense and personnel expenses as shown in Table-9.2.

Table-9.2 Operation and Maintenance Costs for 6 District Town Water Supply

Site	Operation, Management & Maintenance Cost (Kina)		
	Stage- I	Stage- II	Stage- III
1) Bereina	4,946	5,082	5,231
2) Kupiano	4,444	4,497	4,599
3) Kwikila	4,746	4,813	4,909
4) Finschhafen	4,890	4,982	5,076
5) Mutzing	4,733	4,838	4,948
6) Oro Bay	4,352	4,387	4,441
Total	28,111	28,599	29,204

9.2 Financial Plan

The Study Team conferred with PNGWB and explained concerning details of the master plan. As a result of the conference, the Study Team obtained enough understanding and the agreement of the PNGWB about the examination process and the result. The PNGWB was required to continue the examination of the embodiment of water supply services in District Towns where water supply facilities improvement by Pilot Project is not done based on this Study.

As the capital for which the PNGWB can use, there is the government capital such as Provinces Development Fund and the support from AusAID, which declared the support for the water supply sector in the future. The consideration of the foreign aid scheme is needed large-scale water supply systems.

CHAPTER 10 EVALUATION OF ECONOMY, FINANCE, SOCIAL AND ENVIRONMENT

10.1 Financial and Economic Evaluation

In the Study Area of 6 District Towns where concrete water supply facilities plans were prepared are evaluated financially and economically. Concerning financial evaluation, the estimated cost of construction in the water supply improvement plan and operation & maintenance cost of facilities are counted as the entire cost. Based on the assumption that Grant funding is provided for the construction of the facilities at the 1st Stage of the master plan, amounts of this Grant, the water rate collected from water supply system operation is handled as the entire benefit. The entire benefit and cost were compared. Due to comparably small number of users and low level of water rate (same as Provincial Town's) the benefit for the water supply systems at 6 District Towns are absolutely not enough. B/C ratio in 15 years (up to the design year 2015) for financial evaluation shows figures, i.e. Bereina 0.06, Kwikila 0.14, Mutzing 0.21, Kupiano 0.06, Finschhafen 0.13, Oro Bay 0.03.

On the other hand, in the economic evaluation, obtaining reliable quantitative data of the benefit is very difficult in this case. However, the current governments budget spent for operation & maintenance of the unreliable water supply systems, the operator's salary, medical care cost for the cases of water related diseases, the cost of "unable to work" during the sickness and the cost of water fetching estimated in terms of "unable to work" during the water fetching work are listed. And these costs were turned into the benefits for the case of "with the Project" is done in order to have the quantitative figure of the benefits. As the cost for the above economic evaluation, similar to the case of financial evaluation, the construction cost of the facilities and operation & management cost are included. Additionally saved subsidies of the government are counted as the benefit. The above mentioned cost, Grant funding for construction of the 1st Stage are counted as the cost. As a result of economic evaluation for 15 years up to the target year, B/C ratio were indicated at 6 District Towns, i.e. Bereina 0.91, Kwikila 1.57, Mutzing 2.18, Kupiano 1.87, Finschhafen 1.62, Oro Bay 1.43 (please refer to the Data Book, 2. Economy, Finance, Institution and Legal Framework).

All of the water supply systems of 6 District Towns have difficult conditions financially, but as the economic evaluation indicates the benefits of the water supply improvement are significant. It is assumed that this confirms importance of the Project in aspect of social development. Therefore, under the Pilot Project the subsidies from Provincial Government and Local Level Government are discussed and recommended to MOU and MOA by the concerned agencies.

10.2 Social Impact

It cannot be said that water supply services give a negative impact on society. Yet, in promoting water supply services in District Towns by PNGWB, the sole worry is that if the services are provided only for formal residents, benefits will be devoted to only people with social or economic advantage. Considering that water is the most fundamental and indispensable resource for living, it will be a big problem if such services bring benefits only to those already advantaged.

Meanwhile, a positive effect is that people will get stable, safe and sufficient supplies with ease, so that the living environment and sanitation is improved. In villages like Kupiano and Oro Bay, since water sources are far from villages, villagers spend a lot of time carrying water. Thus, water supply services will bring a prominent effect to improving the life of women.

In addition, circumstances at medical institutions entail some wards or delivery rooms being closed in some clinics assumedly because of water shortages. And at Study Areas where the water supply is not stable, clinics cannot fully function. In light of this situation, improvement of water services will bring about a better medical environment. Moreover, it is said that educational institutions such as high schools or vocational schools at the surveyed sites are closed annually because of water shortages. Therefore, improvement to the water situation may also bring about a better educational environment. These factors should not only have a positive effect on the Study Areas of the water services, but also peripheral villages indirectly.

10.3 Environmental Consideration

This Study concerns the groundwater development for water supply systems. When we implement the water supply project we should consider the environmental factors namely construction phase for water supply system and operation phase for water supply system.

1) Water Supply System Construction Phase

The construction works for water supply system consist of borehole, intake facilities, distribution and supply facilities. However, there are no serious construction works such as topographic changes and earth reforming at the eight Study Areas. Therefore, it is considered there are no environmental impact factors during the construction phase.

2) Water Supply System Operation Phase

Considering operation phase for water supply we should consider the two environmental impact factors namely natural environment and pollution. Therefore, groundwater pumping might be the impact factor for water supply system as follows.

- a. Decline in groundwater level: There are no other boreholes, which might be influenced by the operation of this groundwater pumping for District Town water supply.
- b. Saline water intrusion: The aquifers of Daru and Finshhafen consist of coral reef limestone. Therefore, groundwater drawdown should be minimized to avoid saline water intrusion.
- c. Land subsidence: There is no serious problem due to the thin clay layers in the Study Areas.

CHAPTER 11 PILOT PROJECT

11.1 Selection of Pilot Project Areas

(1) Direction for Operation, Management and Maintenance (O, M & M) of District Town Water Supply and the Pilot Project

The direction for O, M & M of District Town water supply, which had been steered from the Phase-I Study in 2000, was proposed to PNGWB. Based on the results of Phase-I the objective and the status of the Pilot Project were explained to PNGWB and understood as follows.

The exchange of ideas with the PNGWB and other relevant organizations and discussions within the Study Team were reflected to the implementation of the Pilot Project, Phase-II in 2001.

(2) Conditions for Area Selection of Pilot Project

The following conditions are required for the area of the Pilot Project considering the position and the objective of the Pilot Study.

1) Feasibility of Sustainable Water Supply Service

There is very few water supply service of the District Town in PNG, which is being managed smoothly and sustainable. All six Study District Towns have issues and problems to be solved. Therefore, PNGWB has the policy to work on promotion of the District Town water supply service.

Feasibility to be a sustainable water supply service is assumed to be the most essential requirement for the area selection for the Pilot Project. The water supply improvement plan of the Pilot Project area shall meet the following requirements. Among these requirements many of them are essential and some are supplementary. When all the essential requirements are satisfied in the plan of each District Town, that area becomes verified for the condition of "feasibility of sustainable water supply service".

Table-11.1 Condition of Pilot Project Area

Items			Conditions
① Water Supply Plan	Needs of Water Supply Improvement	Essential	Supply water to the area where needs of the water supply improvement are high, and able to get support from the local residents, the user, and the central & local governments.
	Political Priority	Supplementary	High political priority is given, and advantaged to get the support of the government.
② Water Source	Groundwater	Essential	Water source with good quality, sufficient volume and at convenient location for utilization as a water source.
③ Facility Plan	Appropriate Technology	Essential	Use an appropriate technology considering conditions of rural area and technical level of the contractors, etc. in PNG.
	Investment Cost	Essential	Relatively small investment cost including utilizing existing facility and availability of public electric power supply.
	Operation Cost	Essential	Low operation cost by means to minimize items such as power expense, level and number of the engaging staff, and consumable articles.
④ Operation, Maintenance & Management Plan	Population of Beneficiary	Supplementary	Due to larger beneficiary population more water users and increase of water charges are expected in principle.
	Cost Sharing	Essential	Users have firm willingness to pay and are ready to pay with certain sufficient economical condition such as the income etc.
	Heavy Users	Supplementary	Have some heavy water users like commercial and/or industrial customers within the water supply service area and increase of water charges are expected.
	Support by PNGWB	Essential	PNGWB has facilities such as the current offices of the Water District for supporting the District Town
	Appropriate Personnel	Essential	The human resources with adequate capability can be assigned continuously.
⑤ Applicability as Model	Possibility of Application	Essential	There is no case where the practice of the Pilot Project is not applicable since each site has very different characteristics from others. The practice of the Pilot Project is applicable to other District Town.
	Geographical Characteristic	Supplementary	Geographical conditions of the Pilot Projects represent the diversity of the conditions in PNG such as location at the south or the north side of the main island, on the coast, the highlands (or inland), and islands, etc. (All the Study Areas are in coastal strips except Mutzing which is inland.)
	Effect of Exhibition	Supplementary	Be effective area to have the visit of the locale as the model water supply service by wide parties concerned in PNG for their recognition.

2) Certainty of Proper Implementation of Pilot Project

It is necessary that the implementation of the Pilot Project be completed properly within the period of the Study in 2001. Therefore, it is necessary to consider certainty on the conditions such as the preparation for reception of the Pilot Project on the PNG side, the required construction period, the natural conditions during the construction within the time framework of the Study in Phase-II. Moreover, the budget for the Pilot Project has a ceiling due to its background that it is implemented as part of this Development Study. The conditions of the certainty of proper implementation are as follows, and these conditions are all essential to execute the Pilot Project surely.

Table-11.2 Essential Conditions of Pilot Project

Items		Condition
① Readiness for Execution	Essential	No obstacle on the side of PNG (PNGWB, resident of the area, related government agencies) about the Pilot Project execution from December 2000 to July 2001.
② Construction Period	Essential	It is certain that the construction work for the water facility improvement is completed within the above-mentioned period.
③ Weather & Access	Essential	No obstacle in construction and transportation of equipment & material, etc. with consideration on weather and road condition while majority of the above-mentioned term of works corresponds in the rainy season.
④ Scale of Budget	Essential	An appropriate budget for the Pilot Project to execute as part of the Development Study.

(3) Selection and Evaluation of the Area for Pilot Project

1) Selection of the Area for Pilot Project

The decision for selection and evaluation of the area for Pilot Project among the 6 District Towns was given when the fulfilment of the conditions of the Pilot Project implementation which are described in the preceding explanation is confirmed by evaluation of the water supply master plan for each District Town.

First of all, with respect to the purpose of the Pilot Project, and each District Town is evaluated as to "feasibility of sustainable water supply service", and the candidate areas, as are narrowed. The condition on "Certainty of proper implementation as the Pilot Project" of the potential area is evaluated. When selecting, it is assumed that an area cannot to be a candidate when the "essential condition" is not fulfilled.

2) Evaluation of the Area for the Pilot Project

The prospective area for the Pilot Project was evaluated. The result of the evaluation of the area for Feasibility of Pilot Project considering Sustainable Water Supply Services is summarized in Table-11.3.

Table-11.3 Feasibility of Pilot Project Area

Evaluation Object			Bereina	Kupiano	Kwikila	Finschhafen	Mutzing	Oro Bay
① Water Supply Plan	Needs of Water Supply Improvement	Essential	⊙	⊙	⊙	○	○	⊙
	Political Priority	Supplementary	○	○	○	○	⊙	⊙
② Water Source	Groundwater Potential	Essential	⊙	△	⊙	⊙	⊙	×
③ Facility Plan	Appropriate Technology	Essential	⊙	○	○	○	⊙	○
	Investment Cost	Essential	⊙	△	○	○	⊙	△
	Operation Cost	Essential	○	○	⊙	⊙	○	○
④ Operation, Maintenance & Management Plan	Population of Beneficiary	Supplementary	○	⊙	○	⊙	○	○
	Cost Sharing	Essential	△	△	○	○	○	×
	Heavy Users	Supplementary	△	△	△	△	△	△
	Support by PNGWB	Essential	⊙	○	⊙	○	⊙	⊙
	Appropriate Personnel	Essential	○	○	○	○	○	○
⑤ Applicability as Model	Possibility of Application	Essential	○	○	○	○	○	○
	Geographical Characteristic	Supplementary	○	○	○	○	○	○
	Effect of Exhibition	Supplementary	⊙	○	⊙	△	⊙	○
Total Evaluation			⊙	△	⊙	○	⊙	×

NB ⊙ : Very good /advantageous to implement the Pilot Project, ○ : Good /advantageous,
△ : Fair, × : Bad /disadvantageous

From the above-mentioned evaluation, Mutzing, Kwikila and Bereina are considered more suitable as the Pilot Project areas, while others still seem to be promising. However, the project areas would be finalized after considering "chances of proper Implementation as the Pilot Project".

Therefore, after the evaluation concerning "Feasibility of Sustainable Water Supply Services", the area selection is done concerning "Chances of Proper Implementation as the Pilot Project".

It was evaluated that the execution of the Pilot Project in Kupiano was not easy from the viewpoint of "Chances of Proper Implementation". There is no restriction in the particular execution about Mutzing, Oro Bay, and Bereina. It was judged that about 2-3 areas were appropriate to the number of District Towns, to target the Pilot Project.

Table-11.4 Chances of Proper Implementation as the Pilot Project

Evaluation object		Bereina	Kupiano	Kwikila	Finschhafen	Mutzing	Oro Bay
①	Water Source	Essential	◎	△	◎	◎	×
②	Execution System	Essential	○	○	○	○	△
③	Construction Period	Essential	◎	×	△	×	◎
④	Weather & Access	Essential	◎	×	△	△	◎
⑤	Scale of Budget	Essential	○	×	△	×	◎
Final Evaluation			◎	×	△	×	◎

NB ◎ : Very good /advantageous to implement the Pilot Project, ○ : Good /advantageous, △ : Fair, × : Bad /disadvantageous,

Regarding Oro Bay and Kupiano the water sources have not been finally confirmed due to unsuccessful test drillings and current majority of the population being villagers. And it is difficult to collect water charges from house connections. Therefore, Oro Bay and Kupiano were removed from the selection.

It was evaluated that the execution of the Pilot Project in Kwikila was not easy from the viewpoint of "Chances of Proper Implementation". However, the local government and PNGWB requested to select Kwikila as one of targets in the Pilot Project because the evaluation from the viewpoint on "Feasibility of Sustainable Water Supply Services" for Kwikila is not low.

The above-mentioned evaluation was analysed overall, and three areas, namely Bereina, Kwikila, and Mutzing, were selected consequently as the areas for the water supply system construction in the Pilot Project.

In addition, it is also suggested that a Pilot Project would be implemented in Daru apart from the District Town, although Daru was initially one of the Provincial Towns for Feasibility Studies. The validity has been highly justified as having "Feasibility of Sustainable Water Supply Service" and "Chances of Proper Implementation as the Pilot Project".

11.2 Outline of Pilot Project

The construction of the water supply system was decided as the Pilot Project on the following four areas namely Bereina, Kwikila, Mutzing and Daru. The outline of the Pilot Project executed for each area is shown in the following Table-11.5.

Table-11.5 Outline of Pilot Project

Pilot Project Area		Content of Plan	
1	Bereina	①	Repair and new establishment of water supply systems
		②	Organizing and management of residents, Training on operation and maintenance of water supply facilities
2	Kwikila	①	Repair and new establishment of water supply systems
		②	Organizing and management of residents, Training on operation and maintenance of water supply facilities
3	Mutzing	①	Repair and new establishment of water supply systems
		②	Organizing and management of residents, Training on operation and maintenance of water supply facilities
4	Daru island	①	Introduction of water vending unit in the residential area of low-income group Construction of water vending unit
	Binaturi	②	Environmental study along the Binaturi river Water supply improvement in villages along Binaturi River Water quality investigation of Binaturi River

Table-11.6 shows the summary of components for the improvement of water supply facilities in the above four (4) areas of Pilot Project under the Phase-II in 2001.

Table-11.6 Summary of the Components for the Pilot Project

Area	System		Facilities	
Bereina	1	Intake Facility	Pump Station	Submersible Pump & Pump Pit
				Solar Generating System Diesel Engine Generator
				Pump House
				Concrete Block Fence
	2	Distribution Facility	Water Storage Tank : Elevated Water Tank	
			Distribution Pipe	
			Rehabilitation of Existing Pipe	
3	Supply Facility	Public Faucet		
Area	System		Facilities	
Kwikila	1	Intake Facility	Pump Station	Submersible Pump & Pump Pit
				Power Line (ELCOM)
				Pump House
				Crimped Wire Fence
	2	Transmission Facility	Rising Main Pipe	
			River Crossing	
	3	Distribution Facility	Water Storage Tank : Ground Water Tank	
			Distribution Pipe	
			Rehabilitation of Existing Pipe	
	4	Supply Facility	Public Faucet	
Area	System		Facilities	
Mutzing	1	Intake Facility	Pump Station	Submersible Pump & Pump Pit
				Power Line (ELCOM)
				Pump House
				Crimped Wire Fence
	2	Transmission Facility	Rising Main Pipe	
	3	Distribution Facility	Water Storage Tank : Elevated Water Tank	
			Distribution Pipe	
			Road Crossing & River Crossing	
			Rehabilitation of Existing Pipe	
	4	Supply Facility	Public Faucet	
Area	Location		Facilities	
Daru	1	Daru Town	Water Vending Unit (Public Faucet)	
	2	Binaturi River Area	Hand Dug Well with Hand Pump	
			Rainwater Collection Tank	

11.3 Water Supply Facilities in Pilot Project

(1) Water Supply Facilities in Bereina

It is thought that a lot of District Towns in PNG are facing similar problems as above. Therefore, it is expected that the Pilot Project in Bereina as a case study becomes a model with high diffusion for the future in PNG.

1) Water Demand in Bereina

In the Pilot Project, the design criteria of the master plan were adopted, and details of the water supply plan for each Study Area were confirmed. Based on the results of water demand study in Chapter 7, the supply population of Bereina in Stage-I (2005) are covered by the construction of the water supply system of this Pilot Project. The supply area and supply population of District Town and eight villages in the surrounding of Bereina, 2000-2015 is shown in Table-11.7.

Table-11.7 Supply Area and Supply Population of Bereina, 2000-2015

Water Supply Area		2000		Stage-I 2005	Stage-II 2010	Stage-III 2015	Public Faucet	
		HH	Population					
A	1	Central(Formal Residents)	96	700	773	853	941	—
	2	Health Centre	—	130	143	158	176	—
	3	Community/ Elementary school	—	60	60	60	60	—
B	1	Toreno No.1	7	41	45	50	55	1
	2	Toreno No.2	9	47	52	57	63	1
	3	Ponepone	20	130	144	158	175	2
	4	Paikwa	16	95	105	116	128	1
	5	Koroapaina	5	44	49	54	59	1
	6	Baukeke	23	40	44	49	54	1
	7	Hihive No.1	11	60	66	73	81	1
	8	Hihive No2	7	56	62	68	75	1
Total		194	1,343	1,483	1,636	1,805	9	

Table-11.8 Water Demand in Bereina, 2005-2015

Target Year		2005	2010	2015
Target Population		1,483	1,636	1,805
Demand (lit/day)	DF : Daily Flow	82,538	103,981	127,167
	ADF : Average Daily Flow	99,046	124,777	152,600
	PDF : Peak Daily Flow	118,855	149,732	183,120

Table-11.9 Water Demand and Supply Area of Bereina in 2005

Water Supply Area		Population	PDF (lit/day)	Water Tank
Area-A	Central	916	82,156	80 m ³
Area-B	1 Toreno No.1	45	2,933	
	2 Toreno No.2	52	3,362	
	3 Ponepone	144	9,300	
	4 Paikua	105	6,796	
	5 Karoapaina	49	3,148	
	6 Baukeke	66	4,292	
	7 Hihive No.1	62	4,006	
	8 Hihive No2	44	2,862	
Total		1,483	118,855	80 m ³

2) Water Supply Facilities in Bereina

The water supply system for Pilot Project in Bereina is composed of intake, transmission, distribution and supply facilities.

1. The water supply pipeline was extended from the existing pipeline to eight villages, and public faucets were set up in the villages.
2. Because there is no public electric power supply of ELCOM in Bereina, the solar power generating system is adopted as the power source for water supply system. The standby diesel generator is set up for emergency.
3. Blocked fence of 3.25m in height was adopted in consideration of crime prevention of the solar power generating system and other water facilities

Table-11.10 Pilot Project of Water Supply Facilities and Specification for Bereina

Facility		Specification
Intake Facility	Pump Installation	Submersible Motor Pump : AC 3-Phase, 400V Q: 300 l/min, H: 45 m , and Control Panel
	Pump Pit	RC Mortar Finish, Pressure Gauge, Air Valve
	Solar Generating System	Solar Generating System: 9kw Inverter for the Pump
	Diesel Engine Generator	10 KVA: Generator for the Pump
	Pump House	Reinforced Concrete (RC) and Block Structure: 28m ² Sand Separator, Water Meter, Pressure Switch, Safety Valve, Chlorinator, Alarm Buzzer, and Alarm Light.
	Fence and Gate	Fence : Block Fence, Mortar Finish, L: 115 m with Barbed-Wire Gate : Steel Plate t: 1.5 mm with Pad Lock
Transmission Facility	Rising Main Pipe	PVC ϕ 80~100 mm, Total Length: 50 m
Distribution Facility	Elevated Water Tank	Water Storage Tank : Pre-Fabricated Galvanized Steel, Volume 80m ³ Accessories— Water Level Indicator, Lockable Manhole Cover, Rung Type Ladder (Inside)
		Tank Stand : Earthquake-Resistant Specification Pre-Fabricated Galvanized Steel, 15 m Height RC Foundation Accessories— Grating Deck and Platform with Handrail, Safety Ladder with Cage and Lightning Conductor
	Distribution Pipe	PVC ϕ 25~100 mm, Total Length: 2.8 km with Water Meters and Gate Valves
Supply Facility	Public Faucet	Reinforced Concrete Mortar Finish, 2 Taps x 9 Units with Water Meter and Valves including Soakaway & Drainage Pipe, PVC ϕ 100 mm

The water supply area and the flow diagram of water supply system in Bereina are shown in Fig.-11.1 (1) and (2), respectively. The valves and flow meters were installed for systematic O, M & M of water supply areas. The flow meter is set up in each branch pipeline in consideration of the O, M & M to the specific water supply area. Each public faucet at surrounding villages was installed with a water meter for the water charge collection. The integrated layouts for the water supply system of Bereina are shown in Fig.-11.2.

Figure.-11.1 (1) Flow Diagram of Water Supply Area in Bereina

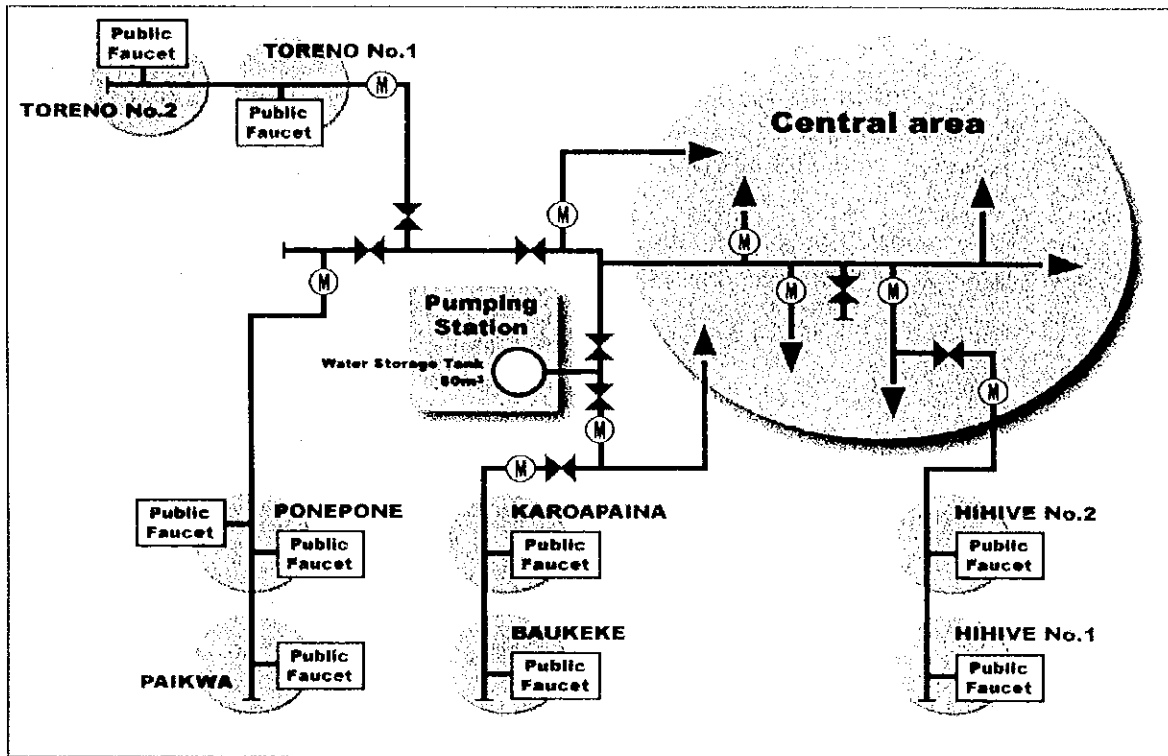
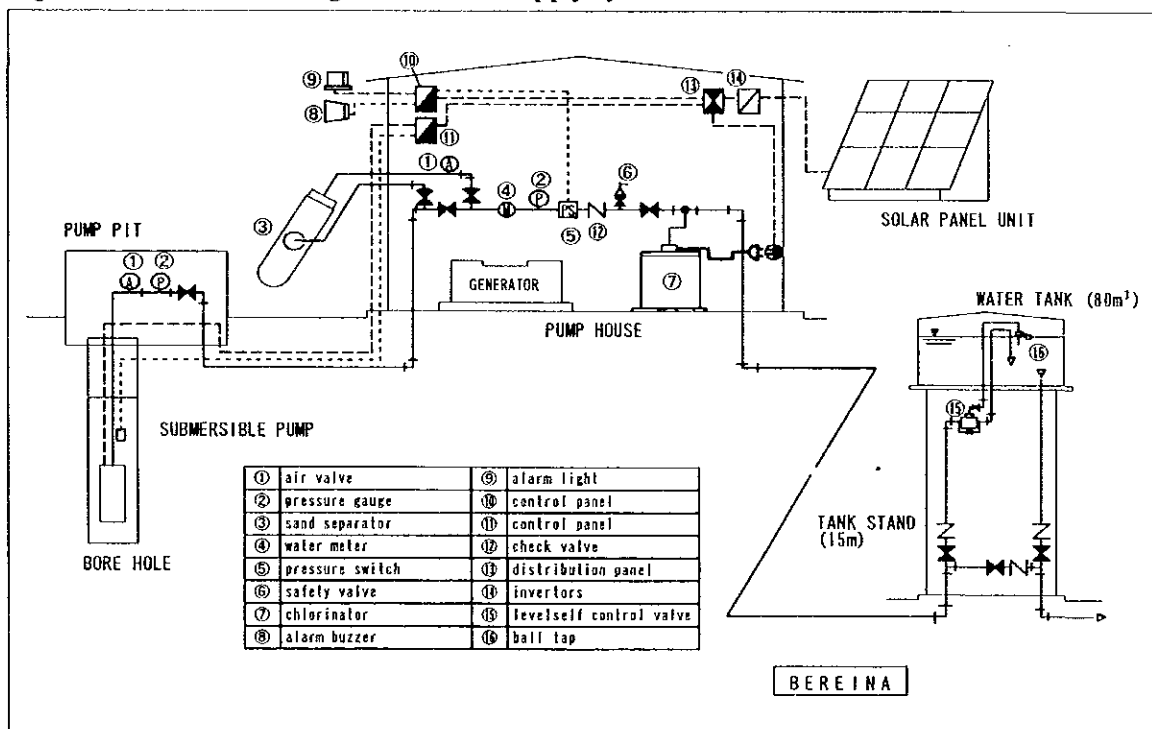
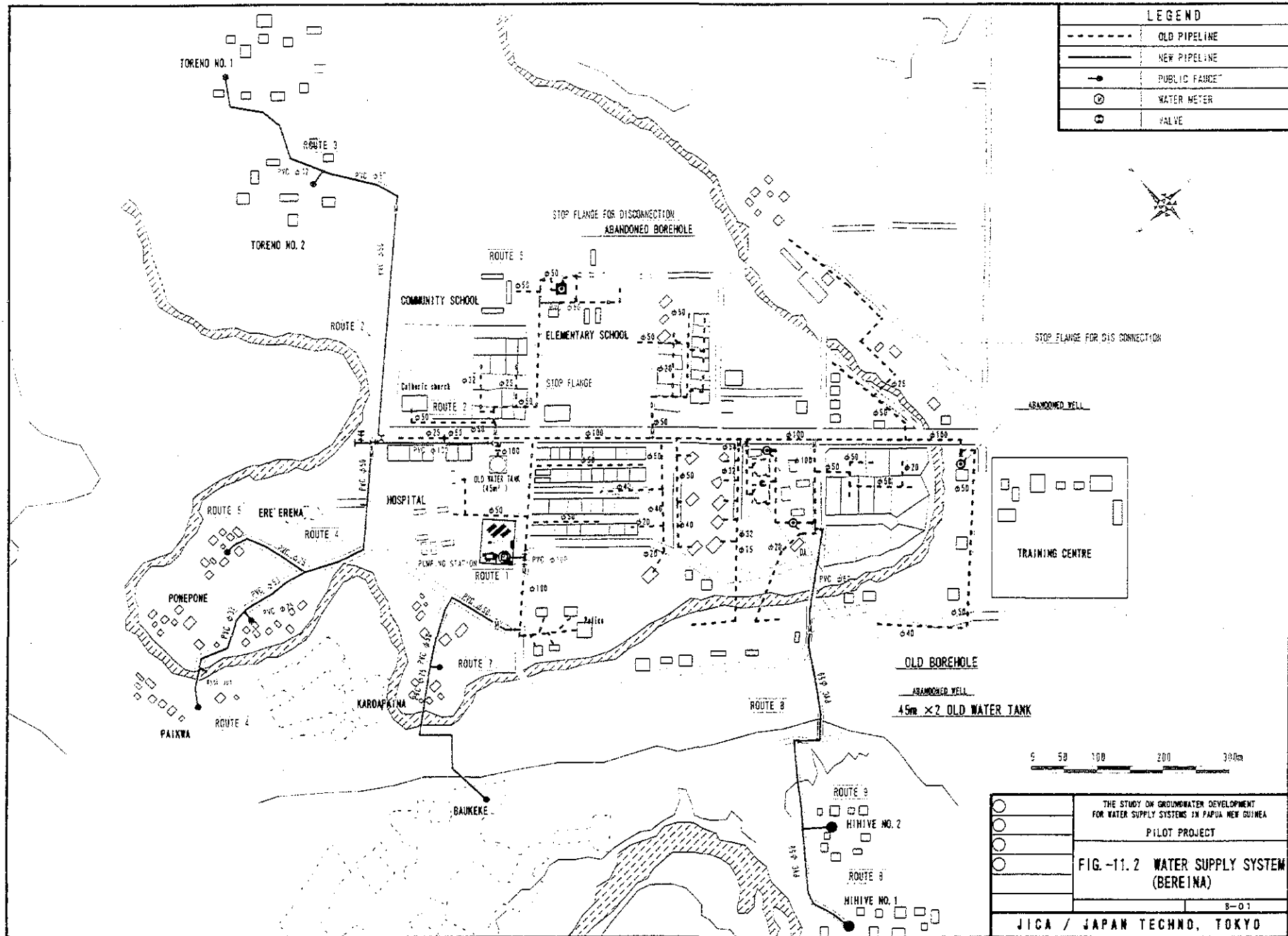
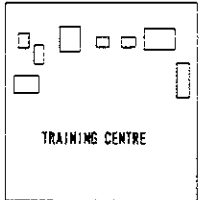


Fig.-11.1 (2) Flow Diagram of Water Supply System in Bereina





LEGEND	
---	OLD PIPELINE
—	NEW PIPELINE
⊙	PUBLIC FAUCET
⊙	WATER METER
⊙	VALVE



	THE STUDY ON GROUNDWATER DEVELOPMENT FOR WATER SUPPLY SYSTEMS IN PAPUA NEW GUINEA PILOT PROJECT
	FIG.-11.2 WATER SUPPLY SYSTEM (BEREINA)
	B-01
JICA / JAPAN TECHNO, TOKYO	

(2) Water Supply Facilities in Kwikila

1) Water Demand in Kwikila

Based on the results of water demand study in Chapter 7, the water supply area and projected population of Kwikila, 2000-2015 was confirmed in the master plan as shown in Table-11.11. Water demand of Stage-I (2005) is planned to be covered by the construction and rehabilitation of water supply facilities in this Pilot Project. The details of water supply area, supply population, households and the number of planned public faucets are shown in Table-11.11.

Table-11.11 Supply Area and Supply Population of Kwikila, 2000-2015

Water Supply Area			2000		Stage-I 2005	Stage-II 2010	Stage-III 2015	Public Faucet
			Household	Population				
A	1	Central	184	1,180	1,302	1,425	1,586	—
	2	Health Centre	—	170	173	177	181	—
	1	Vada Compound	11	70	78	85	94	1
	2	Mr.Broun	2	10	11	12	14	
	3	Makan Compound	14	100	110	122	134	
B	4	Kwikila High school	—	1,000	1,091	1,190	1,302	—
C	5	Vocational Centre	—	318	349	383	421	—
	6	Community School	—	78	81	84	89	—
Total			211	2,926	3,197	3,488	3,821	1

Table-11.12 Water Demand in Kwikila, 2005-2015

Target Year		2005	2010	2015
Target Population		3,197	3,488	3,821
Water Demand (lit/day)	DF : Daily Flow	177,147	205,883	247,184
	ADF : Average Daily Flow	212,576	247,059	296,620
	PDF : Peak Daily Flow	255,091	296,471	355,944

Table-11.13 Water Demand and Supply Area in Kwikila in 2005

Water Supply Area	Population	PDF (lit/day)	Water Tank (m ³)
Area-A : Central (Station)	1,675	146,922	60 m ³ × 2
Area-B : Kwikila High School	1,092	78,383	45 m ³ × 2 (Existing)
Area-C : Vocational Centre	430	29,786	45 m ³ (Existing)
Total	3,197	255,091	210 m ³

2) Water Supply Facilities in Kwikila

The water supply facilities of the Pilot Project in Kwikila is composed of the water intake, transmission, distribution and water supply facility. The contents of each facility and the specification in Kwikila are shown in Table-11.14. The water supply area and the flow diagram of water supply system of Kwikila are shown in Fig.-11.3 (1) and (2), respectively. The valves and flow meters were installed for systematic O, M & M of water supply areas. The one public faucet was installed in the Station of Kwikila, and the water management committee by villagers was planned to manage and collect water charges. However, because of the problems of organization of the water committee by villages the public faucet shall be utilized as a water vending unit decided by the PNGWB for water charge collection. The integrated layouts for the water supply system of Kwikila are shown in Figure-11.4.

Table-11.14 Pilot Project of Water Supply Facilities and Specification for Kwikila

Facility		Specification
Water Intake Facility	Pump Installation	Submersible Motor Pump : AC 3-Phase, 400V Q: 300 l/min, H: 65 m including Control Panel
	Pump Pit	RC Mortar Finish, Pressure Gauge, Air Valve
	ELCOM Power Line	Wiring with Transformer
	Pump House	RC and Block Structure: 28 m ² Sand Separator, Water Meter, Pressure Switch, Safety Valve, Chlorinator, Alarm Buzzer and Light.
	Fence and Gate	Fence: Wire Fence with Barbed-Wire, L: 67 m
Transmission Facility	Rising main pipe	PVC ϕ 80~100 mm, Total Length : 2.2 km including River Crossing
Distribution Facility	Ground Water Tank	Water Storage Tank : Pre-Fabricated Galvanized Steel, Volume: 60 m ³ \times 2 Units Accessories: Water Level Indicator, Lockable Manhole Cover, Rung Type Ladder (inside) RC Foundation
	Distribution Pipe	PVC ϕ 25~100 mm, Total Length : 2.0 km with Water Meters and Gate Valves including River Crossing
Supply Facility	Public Faucet	RC Mortar Finish, 2 Taps x 1 Unit with Water Meter and Valves including Soakaway & Drainage Pipe , PVC ϕ 100 mm

Fig.-11.3 (1) Flow Diagram of Water Supply Area in Kwikila

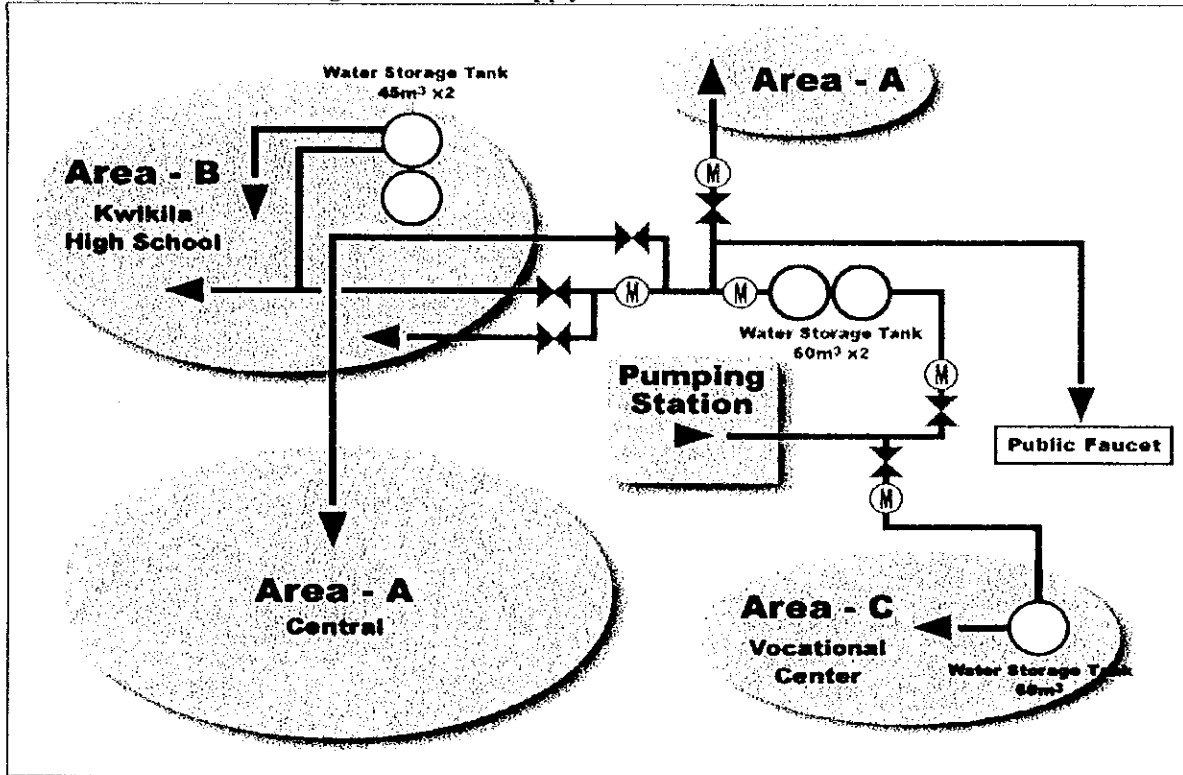
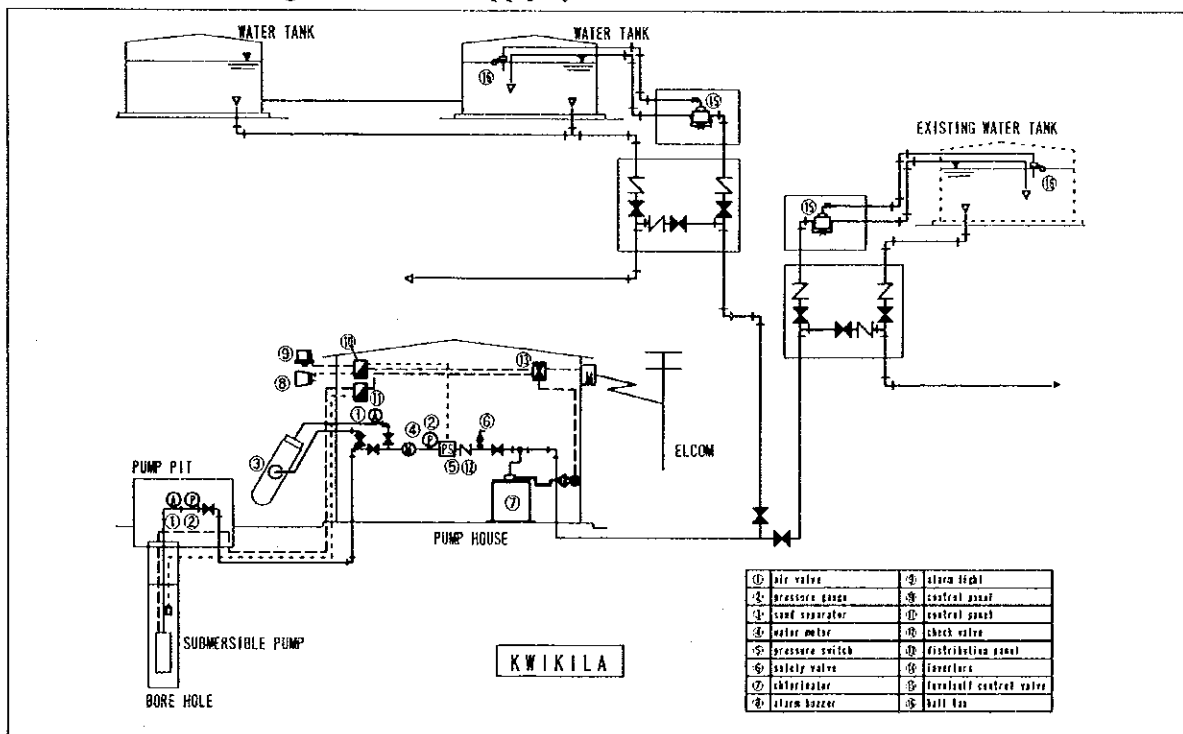
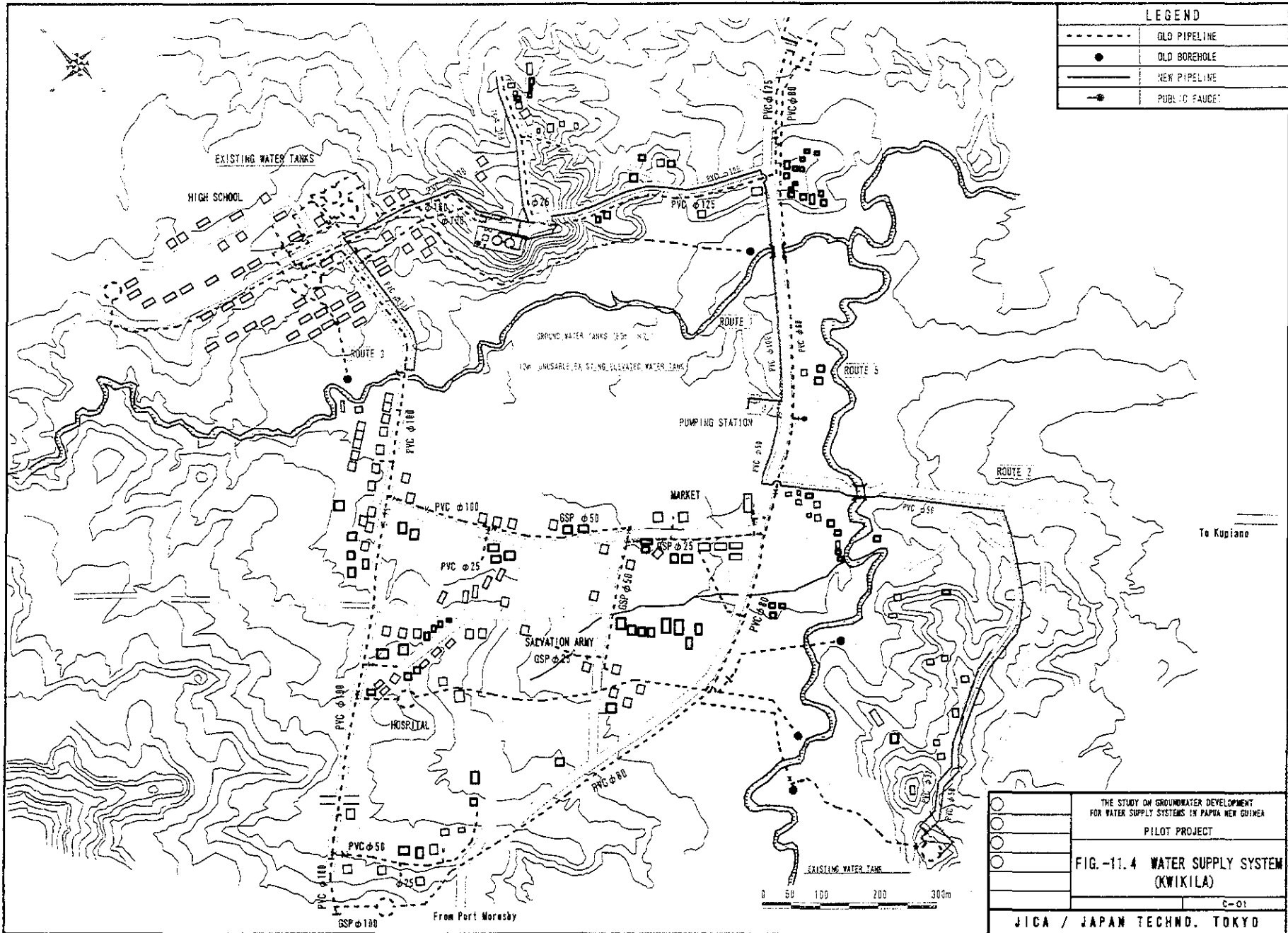


Fig.-11.3 (2) Flow Diagram of Water Supply System in Kwikila





LEGEND	
---	OLD PIPELINE
●	OLD BOREHOLE
—	NEW PIPELINE
⊙	PUBLIC FAUCET

○	THE STUDY ON GROUNDWATER DEVELOPMENT FOR WATER SUPPLY SYSTEMS IN PAPUA NEW GUINEA PILOT PROJECT
○	
○	
○	
	FIG.-11.4 WATER SUPPLY SYSTEM (KWIKILA)
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(3) Water Supply Facilities in Mutzing

1) Water Demand in Mutzing

Based on the study results of projected water demand in Chapter 7, the supply population and supply area of Mutzing was confirmed as shown in Table-11.15. The supply population of Mutzing in Stage- III (2015) is covered by constructing the water supply system in this Pilot Project.

Table-11.15 Supply Area and Supply Population of Mutzing, 2000-2015

Water Supply Area			2000		Stage-I 2005	Stage-II 2010	Stage-III 2015	Public Faucet
			House hold	Popula- tion				
A	1	Central	72	500	556	619	688	—
	2	Intoap Model Village	—	115	128	142	158	—
	3	Health Centre	—	120	133	148	165	—
B	1	Sampubagin Village	37	261	290	323	359	2
	2	Mutzing Village	18	124	138	153	171	1
	3	Community School	—	150	167	187	207	1
C	1	Markhan High School	—	830	923	1,027	1,141	—
Total			127	2,100	2,335	2,598	2,888	4

Table-11.16 Water Demand in Mutzing, 2005-2015

Target Year		2005	2010	2015
Target Population		2,335	2,598	2,888
Demand (lit/day)	Daily Flow	131,696	165,993	202,265
	Average Daily Flow	158,036	199,192	242,718
	Peak Daily Flow	189,643	239,030	291,262

Table-11.17 Water Demand and Supply Area in Mutzing 2015

Water Supply Area	Population	PDF (lit/day)	Water Tank (m ³)
Area-A : Central	1,217	126,741	80 m ³ 31 m ³ (Existing)
Area-B : Villages in East Area	530	49,550	
Area-C : M.V. High School	1,141	114,971	9+10 m ³ (Existing)
Total	2,888	291,262	130 m ³

2) Water Supply Facilities in Mutzing

The water supply system of the Pilot Project in Mutzing is composed of the intake facilities, rising main, and supply facilities similar to the Pilot Project in Bereina and Kwikila. The integrated layouts for the water supply system of Mutzing are shown in Fig.-11.6.

Table-11.18 Pilot Project of Water Supply Facilities and Specifications in Mutzing

Facility		Specification
Intake Facility	Pump Installation	Submersible Pump : AC 3-Phase, 400V, Q: 300 l/min H: 45 m including Control Panel
	Pump Pit	RC Mortar Finish, Pressure Gage, Air Valve
	ELCOM Power Line	Wiring with Transformer
	Pump House	RC and Block Structure, Area: 28 m ² Sand Separator, Water Meter, Pressure Switch, Safety Valve, Chlorinator, Alarm Buzzer, and Alarm Light.
	Fence and Gate	Fence : Wire Fence with Barbed-Wire, L: 67 m
Transmission Facility	Rising main Pipe	PVC ϕ 80~100 mm, Total Length : 50 m
Distribution Facility	Elevated Water Tank	Water Storage Tank : Pre-Fabricated Galvanized Steel, Volume: 80 m ³ Accessories — Water Level Indicator, Lockable Manhole Cover, Rung Type Ladder (inside)
		Tank Stand : Earthquake-Resistant Specification Pre-Fabricated Galvanized Steel: 15 m height RC Foundation Accessories — Grating Deck and Platform with Handrail, Safety Ladder with Cage and Lightning Conductor
	Distribution Pipe	PVC ϕ 25~100 mm, Total Length: 2.4 km with Water Meters and Gate Valves including River Crossing
Supply Facility	Public Faucet	RC Mortar Finish, 2 Taps x 4 Units with water meter and Valves including Soakaway & Drainage Pipe , PVC ϕ 100 mm

Fig.-11.5 (1) Flow Diagram of Water Supply Area in Mutzing

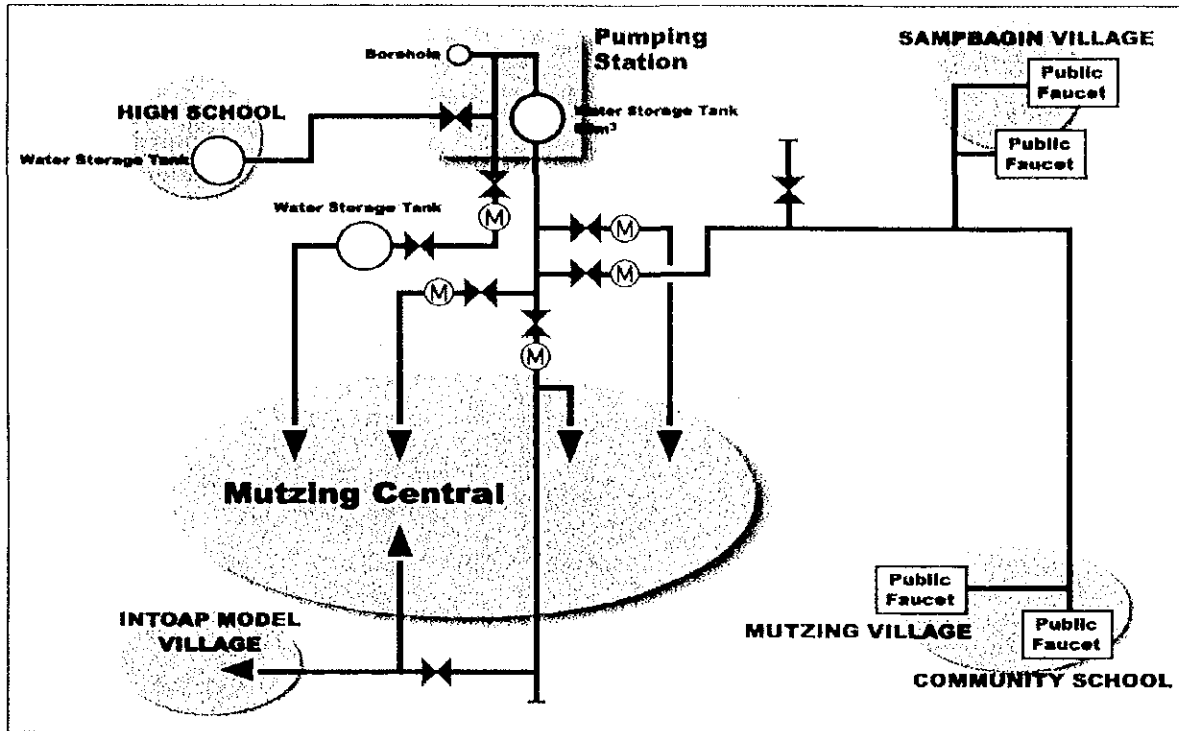
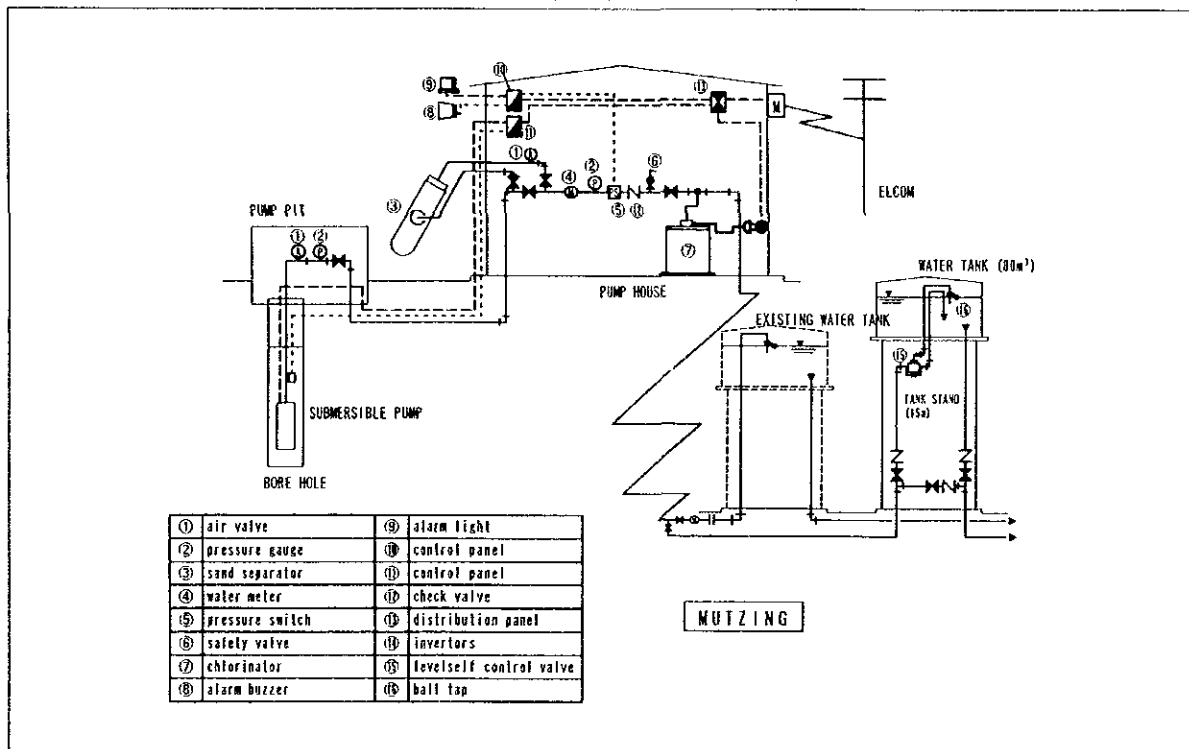
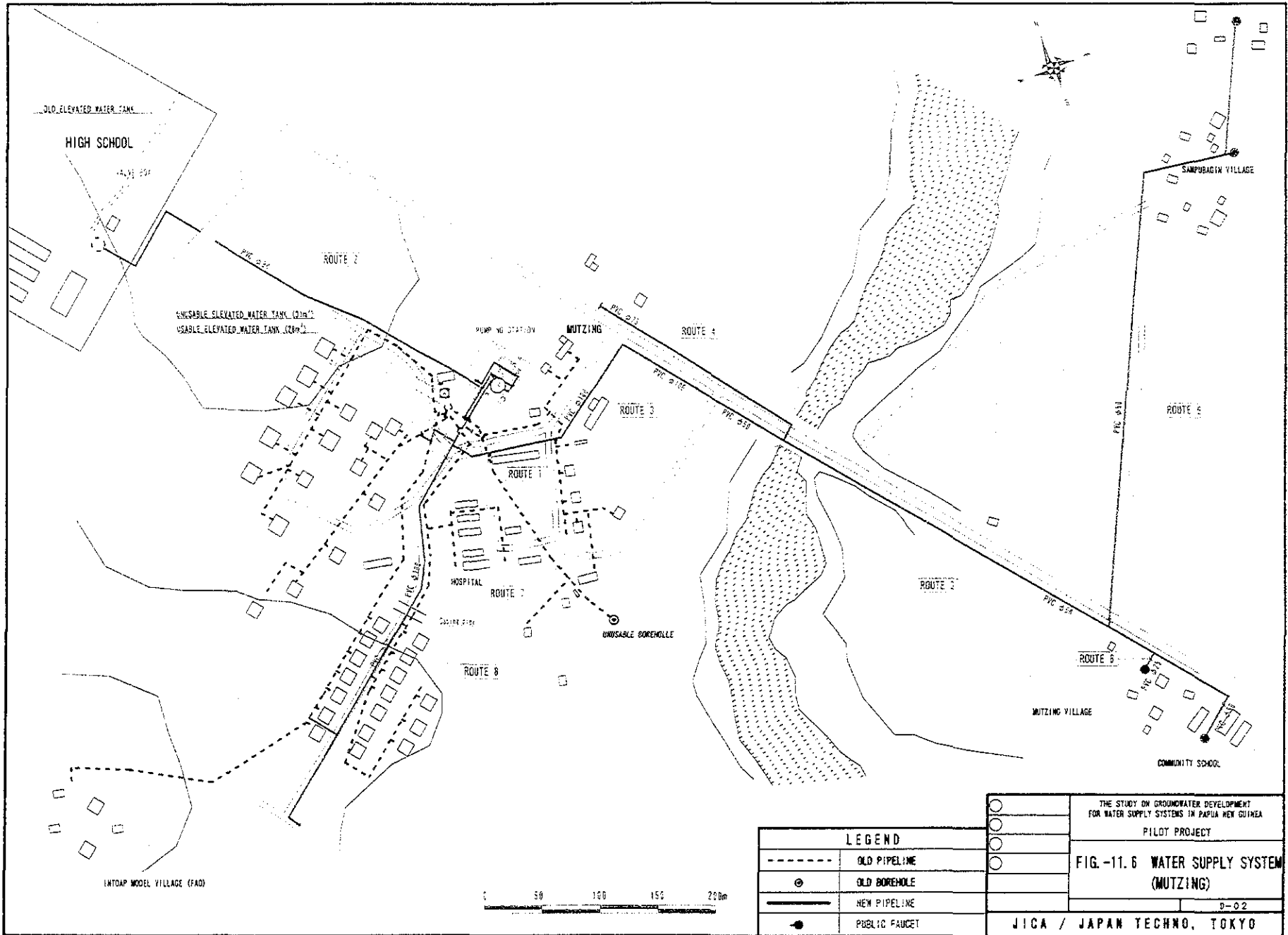


Fig.-11.5 (2) Flow Diagram of Water Supply System in Mutzing





LEGEND	
--- (dashed line)	OLD PIPELINE
⊙ (circle with dot)	OLD BOREHOLE
— (solid line)	NEW PIPELINE
● (circle with dot)	PUBLIC FAUCET

○	THE STUDY ON GROUNDWATER DEVELOPMENT FOR WATER SUPPLY SYSTEMS IN PAPUA NEW GUINEA PILOT PROJECT
○	
○	FIG.-11.6 WATER SUPPLY SYSTEM (MUTZING)
○	
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(4) Water Supply Facilities in Daru

The water supply facilities constructed as Pilot Project in Daru consist of 2 components: the Water Vending Unit on Daru island, and the environmental improvement of Binaturi river. The water supply facilities for each component are shown Table-11.19.

Table-11.19 Water Supply Facilities in Daru

Facility		Specification
Daru Island	Water Vending Unit (Public Faucet)	RC mortar finish, 2 taps with water meter and valves including Soakaway & drainage pipe PVC ϕ 100 Number of Water vending units : 2
Binaturi River	Shallow Wells	Dug well with Hand Pump (ϕ 1.0m) Hand Bore with Hand Pump (ϕ 4" \times 10m) With Tools for Maintenance
	Rainwater Collection Tank	Rainwater Tank, Metal Roof Sheet Rain water Gutter, and Tools for Maintenance

1) Water Vending Unit

The water vending units can improve the shortage of water even in the dry seasons by selling the water to the low-income residential area where the water supply service was stopped. The water vendors sell water by bucket to the water user and PNGWB collects the water charge from the vendors based on the PNGWB current tariffs.

2) Hand Dug Wells and Rainwater Collection Tank

The Pilot Project for construction of hand dug wells and installation of rainwater collection tanks were executed at villages (11 sites) along the Binaturi river based on the development plan which the Binaturi river residents had planned under the support of the Provincial government.

Table-11.20 Village Household and Population in Binaturi Area

	U'ume	Boje	Giringarade	Kunini	Tureture	Masingle	Mawatta	Total
Household	38	67	72	50	61	84	27	399
Population	198	385	425	270	397	497	200	2,372

The procurement of materials necessary for construction of the Pilot Project was executed, in

addition to the construction of the hand dug wells and installation of the rainwater collection tanks through community participation. The main procurement materials are as shown in Table-11.21.

Table-11.21 Procurement of Materials for Binaturi Area

Facility	Materials		
Materials for Construction of Hand Dug Well	1	Hand Auger	Hand Drilling Kit
	2	Steel Form for Casing	Steel Form, Dia.: ϕ 1 m, Height: 0.5 m
	3	Hand Pump	ONGA Pump (NP-90) including Riser Pipe, PVC: ϕ 40 mm with Joint Sockets and Hardwires
	4	Casing Pipe	PVC ϕ 75 mm for Hand Bore
	5	Wood Form	1m \times 1m \times 0.1m including Nails
	6	Cement	Portland Cement (40kg) Bag
	7	Gravel	Size ϕ 5mm & 25mm for Construction
	8	Cover Sheet for Material	Tarpaulin Cover Sheet for Material
	9	Tools for Maintenance	Pipe Wrench, Pliers and Pick
Materials for Construction of Rainwater Collection Tank	1	Rainwater Collection Tank	Polyethylene Tank Split type Volume: 300 gallon included Joint rubber and Hardware
	2	Metal Roof Sheet	Zinc Iron Sheet for Roofing with fixing Materials
	3	Rainwater Gutter	Zinc Iron Gutter with Brackets
	4	PVC Pipe	PVC Pipe for Water Collection
	5	Tools for Construction	Hammer, Metal Sheet Cutter

An example of the shallow well by hand digging is shown on Fig.-11.7.

Moreover, the staff of the NGOs employed by this Project organized a detailed process and the residents' construction with community participation. The manuals of " Hand Dug Well Construction " and " Rainwater Collection Tank Installation " was prepared by the study team as a tool for guidance to the residents to promote understanding on water facilities construction. These manuals are effectively used during the construction work, and proved effective as a tool for communication with the residents.

(5) Tasks on the Papua New Guinean Side

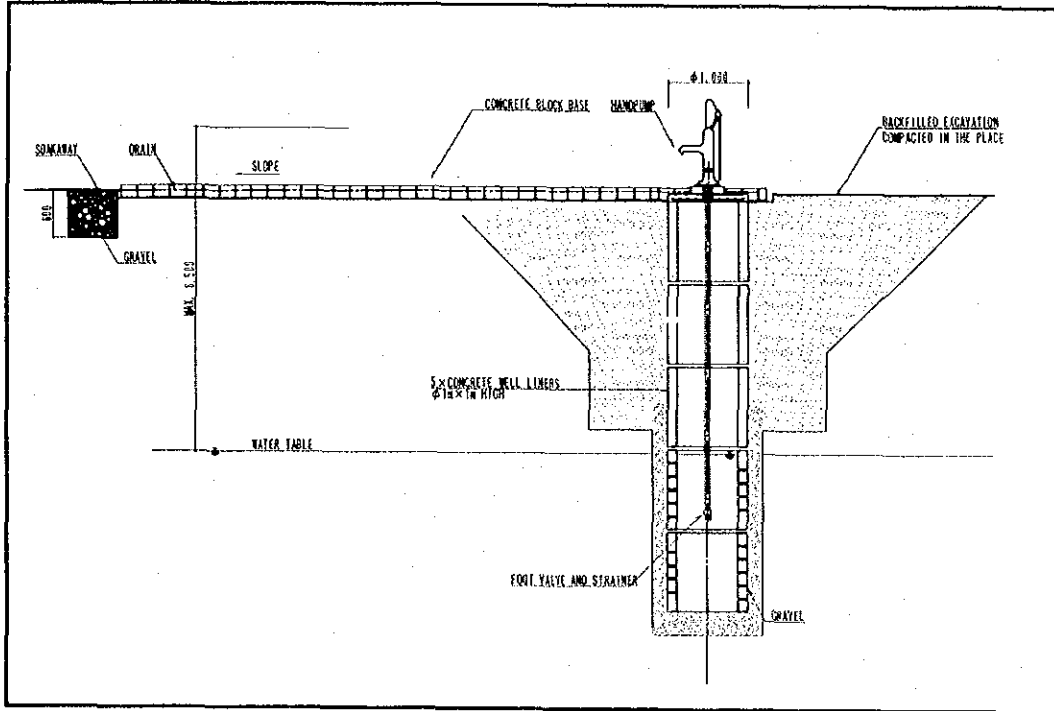
The District Town water supply systems of the Bereina, Kwikila and Mutzing are improved in this Pilot Project, but the works for house connections and repair of taps are excluding the Pilot Project due to the rule of Japanese assistance. Therefore, it is necessary that the Papua New

Guinean side including PNGWB should make house connections and increase new taps based on the requests from the residents. The necessary tasks of the Papua New Guinean side are shown in Table-11.22.

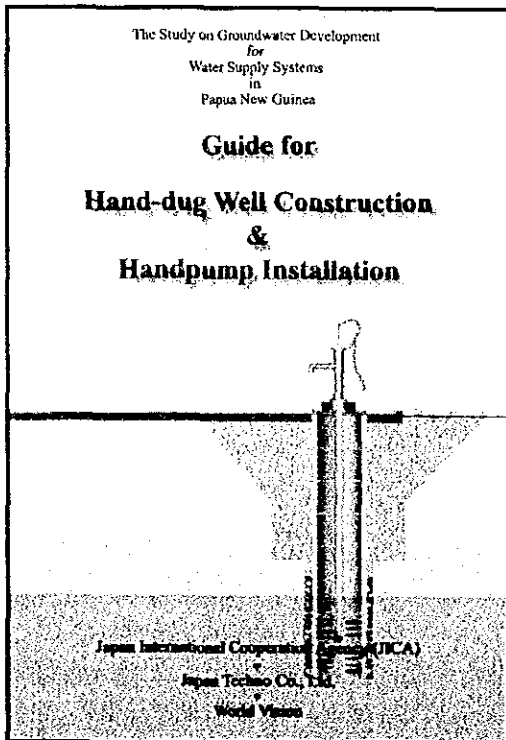
Table-11.22 Responsibility of House Connection for Pilot Project

Item	Actors in Charge
1) Service Connection From main supply pipes to water meters, Max 25m in length	PNGWB
2) House Connection After the water meters to the water taps for residents	Residents or Provincial and/or Local Level Government

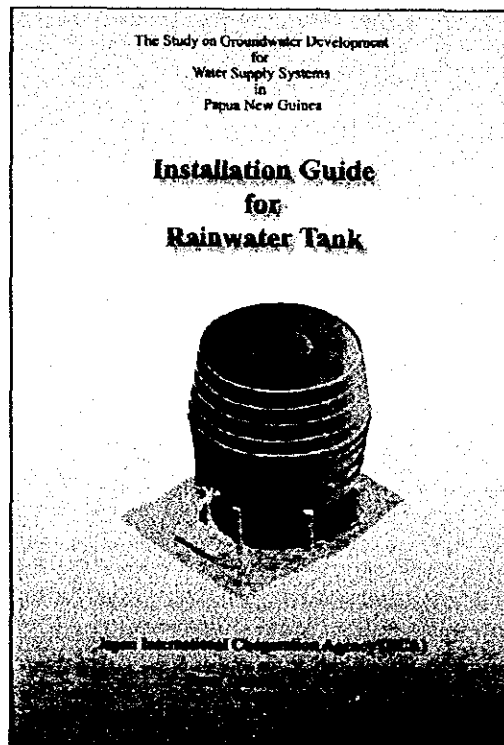
Fig-11.7 Example of Hand Dug Well Construction



Manual of " Hand-Dug Well Construction "



Manual of "Rainwater Tank Installation"



11.4 Water Supply Service Plan

(1) Direction for O, M & M of District Town Water Supply and the Pilot Project

- 1) The direction for O, M & M of District Town water supply, which had been steered from Phase-I of the Study, was proposed to PNGWB. The objective and the status of the Pilot Project were explained to PNGWB and understood.
 - a) Regarding water supply in the Provincial Towns in the entire country, PNGWB has been making its effort to improve the facilities and to upgrade the services mainly utilizing funding of foreign aid. It is expected that all the Provincial Towns will have certain satisfactory level of services of water supply within the coming three to four years under management of PNGWB except Port Moresby, Goroka and Arawa where the services are not provided by PNGWB. On the other hand, water supply situation in rural areas is still very poor due to lack of water supply facilities or even though the facility is there the water supply is insufficient or stopped in most cases. It is assumed that improvement of water supply in rural areas is one of the important missions for PNGWB from now onward. In the rural areas, District Towns are strongholds of public services and development in each District and improvement of water supply at District Towns must be highly prioritized.
 - b) Currently water supply services in District Towns are managed by Provincial Government. However, both capital investment and O, M & M for the District Town water supply are insufficient, and immediate remedies by governmental/public sectors are requested. It is judged that PNGWB is the most suitable organization to fulfill this task, while it is presumed that sustainable O, M & M by Provincial Government and/or Local Level Government is difficult.
 - c) Population of the District Towns is small and the water supply business there is not commercially viable. However, deficit to cover the recurrent cost other than the capital investment cost is not a large amount. If provision of the subsidy to PNGWB by Provincial Government and Local Level Government to cover the deficit is set as the condition, PNGWB can serve for District Town water supply. Currently Provincial Government is bearing the financial burden to run the water supply in the District Town. If the service is improved and managed properly by PNGWB with affordable amount of subsidy it is to the advantage of Provincial Government.
 - d) With the above mentioned assumptions it is thought that establishing a model of water supply in District Towns must be meaningful for promotion of water supply improvement in rural areas of PNG in the future. The Pilot Project is carried out in the areas where such a model can be experimented, among the Study Areas.

- e) All eight Study Areas of this Study were evaluated on adequacy for the Pilot Project from the various viewpoints of water supply plan, O, M & M plan for the Pilot Project and applicability to similar water supply projects as model in future development, and so on. Concerning the water source, the test drilling was done during Phase-I of the Study in 2000 and potential of groundwater was confirmed, and test boreholes can be utilized for production wells in most of the Study Areas. Therefore, utilization of these test boreholes was considered as prerequisite condition for planning of the Pilot Project. Finally Bereina, Kwikila and Mutzing were selected as the sites of the Pilot Project which aimed at improving District Town water supply by rehabilitation and construction of facilities. Meanwhile other components of the Pilot Project were also decided. These are: i) introduction of the water vending unit to service in the residential area of low-income group in Daru Town, ii) water quality and environmental survey in the area along Binaturi River which is the water source for Daru Town water supply, iii) rural water supply project on installation of rainwater collection tanks and hand dug wells through community participation in the villages along Binaturi river.
- f) Implementation of the Pilot Project contains various types of tasks such as rehabilitation and construction of facilities, formulation of O, M & M system, and community development in the water supply areas. Therefore, the appropriate work structure to meet the respective type of task is required and prepared accordingly.

The exchange of ideas with the PNGWB and other relevant organizations and discussions within the Study Team were reflected to the implementation of the Pilot Project. The PNGWB always showed their tireless and constructive attitudes to the project and many relevant staff including the counterpart staff participated in the process. The District administration offices, Local Level Governments and other people recognized themselves as the direct beneficiary of the project and provided cooperation accordingly. Reflecting discussions with PNGWB, the schedule of implementation of the Pilot Project was prepared. The following points related to O, M & M of the District Towns were examined in the preparation of this schedule.

- a) PNGWB and the respective Provincial Government and Local Level Government make the Minutes of Understanding (MOU) on implementation of the Pilot Project to confirm the status of the Project and responsibilities of each party.
- b) PNGWB takes necessary measure to be ready for O, M & M of the water supply systems after rehabilitation and construction are completed. In practice PNGWB decides in its board meeting to recommend to the Minister to declare new Water Districts at Bereina, Kwikila and Mutzing.
- c) PNGWB collects the water charge from the users as their water supply business (applying "User Pay Policy"). When any deficit is made from the operation, the Provincial

Government provides subsidy to PNGWB to cover the shortfall.

- d) PNGWB, the respective Provincial Government and Local Level Government make the Minutes of Agreement (MOA) on O, M & M of the water supply facilities constructed under the Pilot Project to clarify the responsibilities of each party regarding O, M & M.
- e) Enough explanation and information flow to the administrative officers and the residents in the project area shall be performed for appropriate consensus building among them on the Pilot Project and the new water supply services after the Pilot Project.
- f) Any other necessary preparatory work shall be done for the planned O, M & M by PNGWB.

These points were examined by the Study Team and discussed with PNGWB, and other relevant organizations. Consequently, these were reflected in the implementation of the Pilot Project.

(2) Institutional Framework for O, M & M of New Water Supply Systems in District Towns

1) Operation, Management and Maintenance

Through the discussions with PNGWB it was agreed to have an institutional framework for O, M & M of new water supply systems in the District Towns as follows:

- a) PNGWB will operate the water supply systems in Bereina, Kwikila and Mutzing as its Water Districts. According to the National Water Supply and Sewerage Act (NWSS Act) these water supply facilities will become the property of the PNGWB upon the declaration of the new Water District. This includes the facilities that were originally constructed by the Dept. of Works and managed by the Province. Therefore, PNGWB will be responsible not only for day-to-day O, M & M, but also for repair and replacement of facility and equipment, and extension in the future.
- b) Concerning the water supply systems at Mutzing, Bereina, and Kwikila that are renovated by the Pilot Project, PNGWB decided to recommend the minister to declare new Water Districts in the Board Meeting of June 28, 2001. Consequently it is scheduled that Minister of Privatization and Cooperatisation declares the new Water Districts at Mutzing, Bereina and Kwikila in early July 2001. After this declaration, the Water District of Mutzing will be under management of Northern Regional Office, while Bereina and Kwikila will be under Southern Regional Office.

2) Estimated Balance of Revenue and Expenses

Since Phase-I of this Study in 2000, the estimation of revenue, expenses and balance of these new Water Districts were done repeatedly. Recent discussions with PNGWB concerning

details of operation and management at the new Water Districts were reflected in the estimation which was updated as of just before the operation started in June 2001. This part is explained as below.

- a) Revenue: Revenue is limited to the billing of water rate in principle. The water rate is based on the PNGWB's standard tariffs (refer to Table-11.23) and the bills will be charged to the individual and institutional users in the Water Districts. Number of users (individuals and institutions) is counted based on the pre-registration which was done in February to March 2001. The water consumption is basically calculated as the pre-registered population of respective user multiplied by the design water consumption per capita per day. However, water consumption is kept on the conservative side to make sure that actual revenue would reach at least this estimated. The water meter at each user's connection will be read every month and it will be charged by consumed quantity as per the standard tariffs. The water bill will be issued, delivered and paid accordingly. However, for the transitional period from the completion of the Pilot Project construction until the proper billing system becomes ready, temporary billing by a flat rate will be considered since the preparation for setting up the billing system such as installation of water meters, and arrangement of cash handling at the Water Districts will require several weeks.

Table-11.23 PNGWB Standard Tariffs

Water Supply Charge per Month (Kina)	
1. Residential Occupancy /Metered	
Up to 15 kilo litres	4.05 per customer as Minimum Charge (flat rate)
15 to 30 kilo litres	0.58 per kilo litre
Above 30 kilo litres	0.98 per kilo litre
2. Non-Commercial, Government Institutions and Related Occupancy/ Metered	
Metered (per Month)	1.25 per kilo litre, Minimum charge K20
3. Commercial/Industrial Occupancy/ Metered	
Metered (per Month)	1.25 per kilo litre, Minimum charge K20
4. Connection/Junctions Fee	
4-1. New Connection/ Junctions Fee	
For standard new connections of 15mm Not more than 26 m from the nearest main	K60.00 per connection
Connections/Junctions exceeding the above	At cost
4-2. Reconnection	
Where services have not been disconnected	K25.00
Where services have been disconnected and water meter removed	K25.00

NWSS Act, 1986

(1st September 1997)

- b) Expenses: For estimation of the expenses, the following operation and management system at the Water Districts is used as the assumption.
- i) Staff: Personnel cost is a large burden for small scale water supply systems, and minimizing this cost as much as possible shall be considered when operation and management system is designed. In the Water District a Water Operator of PNGWB will be stationed. The required qualification for Water Operator is PNGWB's Grade 7 or higher and knowledgeable on plumbing work. As an assisting staff to the Water Operator, an assistant will be employed locally. This assistant shall be with qualification of PNGWB's Grade 4. The management of the entire system will be done by the Regional Manager. In case of Bereina and Kwikila the Regional Manager is stationed at the Southern Regional Office in Port Moresby, while Mutzing will be managed similarly by the Regional Manager at the Northern Regional Office in Lae. The Regional Manager shall visit the Water District every two weeks in principle, and does the administrative and managerial work for the Water District. The Water Operator shall do daily operation and inspection, recording of operation data, meter reading, reporting to the Regional Office, simple repair and relevant plumbing work. Based on the meter reading, the water bills shall be issued at the Regional Office and the bills shall be delivered by the Water Operator. When it is required, the Water Operator also shall organize sales promotion activity and public relations campaign including "Pay Water Bill" campaign. The data of meter reading and delivery of the water bills between the Water Operator and the Regional Office will be done when the Regional Manager visits the Water District for supervision and/or when the Water Operator visits the Regional Office for reporting. In principle water fee collection will be done at the National Treasurer's account counter at the District administration by delegation from PNGWB to the District administration. When necessary the Regional Office dispatches its cashier or adequate staff to the Water District to fulfil the fee collection. The personnel cost of the Water Operator and the Assistant shall be charged to the Water District and the cost of the Regional Manager shall be absorbed by the general administrative cost.
- ii) Energy Cost: In Bereina, solar generating system is used and a stand-by diesel engine generator is set for supplementary energy source when irradiation in daytime is not enough depending on weather condition. This generator shall be run when it is necessary. In Kwikila and Mutzing, ELCOM supplies constant public power supply. The cost of electricity will be charged as per the ELCOM's rate.

- iii) Chemicals: Breaching powder for chlorination is only one chemical to be used in the new water supply system and it will be procured by the Regional Office and delivered to the Water District. The cost shall be charged to the Water District. It is expected that the procurement together with chemicals for other Water Districts minimize the procurement cost.
 - iv) Office Cost: There is a simple office space within the pump house. If required an appropriate office space can be provided by the District administration. The details shall be concluded between PNGWB and the District administration. The office may require procurement of office furniture, office equipment and the procurement will be done by the Regional Office and the cost will be charged to the Water District as the depreciation accordingly. The procurement shall be limited to the minimum items which are essential for the work for a while. Similarly the consumables shall be arranged.
 - v) Other Expenses: Installation of security alarm equipment, insurance coverage for facilities and staff, and procurement of bicycle for the Water Operator to make the round for inspection in the Water District, shall be done by the Regional Office. These costs also shall be charged to the Water District accordingly. The transport cost for the Water Operator's visit to the Regional Office for reporting and the general administration cost of the Regional Office are considered. Installation of radiophone is proposed for the communication between the Water Districts in Bereina and Kwikila and the Southern Regional Office in Port Moresby. It is assumed that use of radiophone is effective since the service of TELIKOM is not reliable in these areas.
- c) Estimated Financial Balance: Based on the above described revenue and expenses for operation of water supply systems the financial balance of each Water District was estimated. The details for respective Water District are shown as below.
- i) Bereina:
The pre-registration of users for the residents and institutions within the station of Bereina was done. These users will receive water supply service from the existing distribution pipeline and its extensions with house connections. There are eight public faucets constructed by the Pilot Project in the surrounding villages, and each public faucet has a water committee formed by the village residents. The water committee will identify the household who will use the facility and share the water charge. Certain amount of money will be paid by these users as reserve for the water committee.

The water consumption and the water charge of each user group calculated from this pre-registration data are indicated in the following table. Details of the calculation are shown in Table-11.24.

Table-11.24 Water Consumption and Water Revenue of Bereina

Type of User	Pre-Registered Users Number	Estimated Consumption (m ³ /month)	Estimated Revenue (Kina/month)
House (incl. houses owned by Provincial Government)	70 households	840	336
Public & Private Institution (administration office, health centre, school, church, shop, etc.)	19 institutions	300	221
Village/Settlement	96 households	350	47
TOTAL	185 users	1,490 m³/month	604 Kina/month

As a result of the above estimation, the revenue of Bereina WD is assumed as approximately K604 per month. On the other hand, its expenses are estimated as follows in Table-11.25.

Table-11.25 Details of Operation Cost (Expense) of Bereina

Item of Expense	Unit Price	Quantity	Base of Calculation	Expenses
Energy Cost: Stand-by Diesel Engine Generator (10KVA)	K0.842 / litre	Fuel consumption 10 litres/hour Operation 60.83 hours/ month 608 litres/ month	Solar power source: 5 hours run /day Generator: 2 hours run / day	K512 / month
Chemicals: Bleaching Powder for Chlorination	K177.84 /40kg bag, Purity 70%	Injection ratio 0.0001%	Water quantity for chlorination 1,790 m ³ /month	K12 / month
Personnel: Water Operator Assistant	Water Operator: PNGWB's Grade7, existent trained operator of PNGWB Assistant: PNGWB's Grade4, locally employed			K2,478 / month
Office Expense:	Depreciation of furniture, equipment, transport fee for reporting			K437 / month
Insurance:	Asset value as K1.2million (cost of PNGWB's existent water district is applied)			K416 / month
Administration:	Temporary lump sum is charged in the initial stage. Cost of Regional Manager, bill issuance, etc. are considered.			K1,000 / month
TOTAL				K4,855 / month

The financial balance from the above mentioned revenue (K604) and expenses (K4, 855) will become deficit of K4, 251 per month. This means that further effort to reduce this amount of deficit and also Central Provincial Government has to provide subsidy to cover the shortfall. Amount of the subsidy shall be decided between PNGWB and Central Provincial Government in the Consultation Meeting (at least one meeting per year shall be held) stipulated in the MOA. The budget appropriation by Central Provincial Government is required and the Study Team presented the proposed amount of the subsidy at K4,500 per month (K54,000 per annum) and recommended to reflect to its budget of the next fiscal year.

Table-11.26 Monthly Balance of Operation Cost of Bereina

Revenue	K604
Subsidy from PG/LLG	K4,500
Expenses	K4,855
Balance	K249

ii) Kwikila:

Similarly to Bereina's case the users will receive water supply from the house connection of the existing pipelines and its extensions. However, in case of Kwikila more than 7 years passed since the existent water supply system had stopped, and this may require continuation of rehabilitation of distribution pipeline. For the residents of the settlements within the station, one public faucet was installed. This facility will be shared by the residents of three settlements nearby and one water committee was formed by the residents. The identification of the user households and preparation of the reserve for the committee are on-going.

The water consumption and the water rate of each user group calculated from this pre-registration data are indicated in the following table.

Table-11.27 Water Consumption and Water Rate (Revenue) of Kwikila

Type of User	Pre-Registered Users Number	Estimated Consumption (m ³ /month)	Estimated Revenue (Kina/month)
House (incl. houses owned by Provincial Government)	86 households	1,459	825
Public & Private Institution (administration office, health centre, school, church, shop, etc.)	18 institutions	1,977	2,035
Village/Settlement	27 households	97	4
TOTAL	131 users	3,533m³/month	K2,864/month

As a result of the above estimation, the revenue of Kwikila WD is assumed as approximately K2, 864 per month. On the other hand, its expenses are estimated as follows.

Table-11.28 Details of Operation Cost (Expense) of Kwikila

Item of Expense	Unit Price	Quantity	Base of Calculation	Expenses
Energy Cost: ELCOM Power Supply Pump: 3.7KW, Chlorinator:0.14KW)	K0.184/KWh	517 hours/month 1,986KWh/month	Operation: 17 hours / day	K365/month
Chemicals: Bleaching Powder for Chlorination	K177.84 /40kg bag, Purity 70%	Injection ratio 0.0001%	Water quantity for chlorination 4,240m ³ /month	K27 / month
Personnel: Water Operator Assistant	Water Operator: PNGWB's Grade7, existent trained operator of PNGWB Assistant: PNGWB's Grade4, locally employed			K2,478 / month
Office Expense:	Depreciation of furniture, equipment, transport fee for reporting			K437 / month
Insurance:	Asset value as K1.2million (cost of PNGWB's existent water district is applied)			K416 / month
Administration:	Temporary lump sum is charged in the initial stage. Cost of Regional Manager, bill issuance, etc. are considered.			K1,000 / month
TOTAL				K4,723/ month

The financial balance of the above indicated revenue (K2,864) and expenses (K4,723) results as deficit of K1,859 per month, and similarly to the case of Bereina, effort to minimize the deficit and subsidy from the Provincial Government is required. The subsidy amount shall be discussed between PNGWB and the Provincial Government in the Consultation meeting as stated in the MOA. As the recommendation, the subsidy of K2,500 per month (K30,000 per annum) was proposed by the Study Team to the Provincial Government to secure the budget in the next fiscal year.

Table-11.29 Monthly Balance of Operation Cost of Kwikila

Revenue	K2,864
Subsidy from PG/LLG	K2,500
Expenses	K4,723
Balance	K641

iii) Mutzing:

The water consumption and the water rate of each user group in Mutzing were estimated with the data of pre-registration in the station area. These users will receive water supply service with house connections from the existing pipelines and its extension. There are four public faucets which were built by the Pilot Project and these will be used by the residents of these surrounding villages. Each public faucet has its Water Committee and the committee is doing identification of the user households and collecting money for reserving the deposit for the payment of water rate.

Table-11.30 Water Consumption and Water Rate (Revenue) of Mutzing

Type of User	Pre-Registered Users Number	Estimated Consumption (m ³ /month)	Estimated Revenue (Kina/month)
House (incl. houses owned by Provincial Government)	81 households	881	635
Public & Private Institution (administration office, health centre, school, church, shop, etc.)	25 institutions	1,367	1,143
Village/Settlement	90 households	324	63
TOTAL	196 users	2,572m³/month	K1,841/month

As a result of the above estimation the revenue of Mutzing water district is assumed as approximately K1,841 per month. On the other hand, its expenses are estimated as follows.

Table-11.31 Details of Operation Coast (Expense) of Mutzing

Item of Expense	Unit Price	Quantity	Base of Calculation	Expenses
Energy Cost: ELCOM Power Supply Pump: 4.0KW, Chlorinator: 0.14KW	K0.184/KWh	395 hours/month 1,637KWh/month	Operation: 13 hours / day	K301/month
Chemicals: Bleaching Powder for Chlorination	K177.84 /40kg bag, Purity 70%	Injection ratio 0.0001%	Water quantity for chlorination 3,090m ³ /month	K20 / month
Personnel: Water Operator Assistant	Water Operator: PNGWB's Grade7, existent trained operator of PNGWB Assistant: PNGWB's Grade4, locally employed			K2,478 / month
Office Expense:	Depreciation of furniture, equipment, transport fee for reporting			K437 / month
Insurance:	Asset value as K1.2million (cost of PNGWB's existent Water District is applied)			K416 / month
Administration:	Temporary lump sum is charged in the initial stage. Cost of Regional Manager, bill issuance, etc. are considered.			K1,000 / month
TOTAL				K4,652/ month

The financial balance from the above mentioned revenue (K1,841) and expenses (K4,652) is deficit of K2,811 per month. The reducing of the deficit amount and provision of subsidy by Morobe Provincial Government and Umi-Atzera Local Level Government is required to cover this shortfall. Amount of the subsidy shall be discussed and decided in the Consultation Meeting between PNGWB and Morobe Provincial Government and Umi-Atzera Local Level Government. The subsidy of K3,000 per month (K36,000 per annum) was proposed by the Study Team for the budgeting in the coming fiscal year.

Table-11.32 Monthly Balance of Operation Cost of Mutzing

Revenue	K1,841
Subsidy from PG/LLG	K3,000
Expenses	K4,652
Balance	K189

3) Operation, Management and Maintenance of Water Vending Unit introduced in Daru and Rural Water Supply Facilities in Villages along Binaturi River

Apart from the District Town water supply, the Pilot Project introduced Water Vending Unit in Daru and rural water supply facilities (rainwater tanks and hand dug wells) in the villages along Binaturi River. The O, M & M of these facilities are planned as follows.

a) O, M & M of Water Vending Unit in Daru

In the urban area, there are some areas where mainly low-income groups reside. It is seen very often in such an area that some town water supply users fail to pay the water bill and are disconnected. Consequently these residents start using unsanitary water from unprotected dug well or water hole. It was confirmed in Phase-I that also in Daru there are certain number of households who failed the water bill payment and disconnected in the areas where low-income group resides. However, these residents are buying a bucket of water at more expensive price, and nevertheless they failed to pay the water bill. Therefore, it was assumed that selling water per bucket at reasonable price at officially installed public faucet would contribute a lot to improve the water supply condition of these residents. For this purpose the component to install two public faucets as the Water Vending Unit and to supply water to these residents in this area was proposed to PNGWB. This was accepted and implemented. For PNGWB similar situation is found in various Water Districts other than Daru and interest on the result of this component is shown.

- Operation of the Water Vending Unit is simple and does not require special skills. O, M & M system of Water Vending Unit is planned as follows.
- Concerning location of the Water Vending Unit, following factors were considered for selection. Water supply situation in the area, existence of the residents who are disconnected due to failure of payment, water demand and willingness to pay among the residents, etc. The areas where reaction of the residents is positive and candidates of water vendor are found, and land dispute is not existing were selected.
- Prior to the installation of the Water Vending Unit, the minutes of agreement was agreed among the water vendors (individuals) and PNGWB together with Fly River Provincial Government and Daru Town Local Level Government as the supervisors of appropriate O, M & M.
- Water Vendor shall receive the approval of PNGWB for the selling price of the water to the residents. When it is found that Water Vendor sells at unjustifiable price the Water Vendor shall be penalized.
- Water Vendor shall pay the water rate as per the standard rate of PNGWB. Meter reading shall be done at the Water Vending Unit and the bill shall be delivered to the Water Vendor for the payment. However, in case of high level of sales at the Water Vending Unit the water bill should become high. Therefore Water Vendor shall deposit every week the amount equivalent to 25% of the estimated monthly bill. This is to avoid any trouble of payment by the Water Vendor.
- The facility of Water Vending Unit is property of PNGWB. The day-to-day cleaning and maintenance of the facility shall be done by the Water Vendor and repair will be done by PNGWB when necessary.

When operation of the Water Vending Unit is started, PNGWB Daru Water District Office frequently inspects and monitors the operation at the sites during the initial operation stage.

b) O, M & M of the Rural Water Supply Facilities in the Villages along Binaturi River

Water source of Daru Town water supply is Binaturi River that is located in the mainland. Along this River there are several villages. However, these villages hardly have water supply facilities. The residents of these villages are frustrated since they suffer from shortage of water during dry season while water is pumped from Binaturi River to Daru Town. There are incidents that some of the residents occupy pumping facility and interrupt operation of water supply system. PNGWB is regarding this as a considerable issue.

Installation of rainwater collection tanks and construction of hand-dug wells as rural water supply

facilities for these villages where residents suffer from unstable water supply were proposed by the Study Team and implemented with consent of PNGWB.

The work to be done for installation of rainwater collection tanks and construction of hand-dug wells are comparably simple and it is suitable to be done by the residents when technology transfer is provided. The residents agreed to do the work as their participation and will continue construction work by themselves. By community development activity water committees were established in the villages and Binaturi River Development Corporation (BRDC) which is the higher organization in the area is supported to continue improvement of the water facilities. These community based organizations will be responsible for O, M & M of the water facilities. Although the water facilities are very simple and do not require much attention like piped water supply system, it is assumed that it will take time to reach a stable O, M & M by the residents. As the technology required for these facilities are simple, Health Division's water & sanitation team of Western Province can assist them visiting from Daru. The Government of Western Province has confirmed that this activity would be supported by the Provincial Government.

11.5 Plan to Organize People

1) Organization of Water Management Committee

i) The Pilot Project Sites of Kwikila, Bereina and Mutzing

The main objectives in organizing Water Management Committees are to conduct maintenance of installed public faucets through the participation of beneficiaries. In the Pilot Project, informal residents are exempt from the target related to the organization, because each formal resident household is expected to make a contract with PNGWB as is the case in other Provincial Towns in which PNGWB operates.

The reasons for installing public faucets are as follows. First, the cost of installing water taps and extension pipes in households at a user's own expense is thought to be difficult for informal residents/villagers. Secondly, it is expected that regular monthly water charge payments per household are rather difficult for this group of people according to experiences at other sites.

Reasons for the organization and participation method are as follows. First, it is obvious that PNGWB cannot directly take care of the public faucets and other organizations like local municipalities do not have enough capability to substitute its services. Therefore, unless the

beneficiaries themselves participate in maintenance, the water supply services are thought to be unsustainable. Secondly, in the case of water supply services by way of public faucets, operations should be adjusted in accordance with the actual situation at each site and such flexibility would be realized most effectively through the participation of beneficiaries. Water supply services operated by beneficiaries are seen in many developing countries, however, this is the first time for PNGWB.

Although at the beginning of the Pilot Project, Water Management Committees had planned to be organized per public faucets, in reality however, several public faucets have been grouped along main water pipes and one committee has been organized for them considering the maintenance work requirements of some sites. The unit for one organization is varied and the committee covers part of one area - a whole village or the entire group of informal residents of one District Town. It would be useful to conduct an inquiry to detail the difference between different units of committees in the future. In addition, as for future projects where sites are separated from the JICA Study like the Islands and the Highlands, it will be required to reconsider more appropriate ways of implementation in light of PNG's rich and complex cultural background.

The main processes of the organization are: 1) Selection of members for the Water Management Committee, 2) Establishment of rules to utilize the public faucets by the Committee, 3) Establishment of a training course for the Committee (management of the organization, facility maintenance, health/sanitation, and accounting), and 4) Initial fund raising. After completing the above process and other required preparation, each committee will be able to register with PNGWB and commence water supply services at each site.

Throughout the period of the Pilot Project, one community organizer, a local NGO staff member, in each site has been allocated to assist the activities of informal residents/villagers. Although their ability has been observed as sufficient in a field staff capacity, their capability is insufficient to supervise the entire above-mentioned process. Therefore, human resources that have sufficient ability to manage the Project, together with adjusting procedures to develop appropriate organizations in accordance with the situation of each Project site will need to be developed.

Table-11.33 Summary of Established Organizations

	Kwikila	Bereina	Mutzing
Number of Public Faucets	1	9	3
Target	Informal residents	Villagers	Villagers
Unit of the Water Management Committee	The unit covers all informal residents	Several communal taps along the same water pipes are grouped.	The committee has been established based on village units.
Number of Water Management Committee	1	4	2

ii) The Pilot Project of Daru

In case of Daru, instead of organizing people, two Water Venders have been selected and given required training for operation, maintenance and management for Water Vending Units. Due to the profit driven and private entrepreneurial approach, the process is rather quicker and simpler than that of public faucet approach. However, the cost borne by each beneficiary (customer) is higher than that of faucet approach. In addition, it is thought to be a potentially problematic approach because of the benefit for the Water Vendors. Thus the occurrence of vandalism had been worried, however, any incident has not been reported since the completion of facilities except the slight mischief by children. It is also crucial to establish certain awareness of communal benefit towards the Water Vending Unit in neighboring residents.

Although this approach seems to be viable in PNG at this stage, some consideration should be required in case of additional implementation. First, the Water Vending Unit should be located in the State Land to avoid involving in any land dispute and compensation issue. Second, the population surrounding the Water Vending Unit is to be enough for generating certain income. In advance, it should be made sure that expected income is attractive amount compared with other small enterprises in each site.

iii) The Pilot Project in Binaturi Area

In case of Binaturi, a Community Based Organization, Binaturi Water Issue Committee, is identified in the first field survey, thus the main objectives are to enhance the organization and adjust the structure for the Pilot Project. Seven (7) villages are located along the Binaturi River and one community organizer, a local NGO staff member, has been allocated to catalyze the above processes. The core part of the Project is to introduce appropriate water supply facilities like rainwater collection tanks, hand pumps with dug well and hand pumps with borehole, and Health Division of Western Province has co-operated with and given technical support to those villages.

Although the basic concept of this Pilot Project was the beneficiaries' participation, it was followed in a very passive way. In short, it would be concluded that the concept of people's participation is not yet so much mature in PNG and more intensive support from specific experts should have been applied.

2) Collection of Water Charges

i) The Pilot Project Sites of Kwikila, Bereina and Mutzing

Water Management Committees accept overall responsibility for maintenance of the public faucets. The estimated required cost includes monthly water charge payments and occasional replacement costs for water taps. The maintenance from main water supply facilities to water meter boxes installed nearby each public faucet will be done by PNGWB, thus the responsibility of committees falls only on the water taps.

It is agreed that K5 per household as an initial fee is collected before official registration with PNGWB and some committees were reported to have already completed this collection. After acquiring the initial fees, the Committees will be officially registered with the PNGWB and will receive water supply services. After starting the water supply services, Committees are responsible for collecting K5 of monthly water charges per household and paying a monthly water charge to PNGWB. At present, usage of water at all sites is limited to drinking and cooking by beneficiaries, therefore the K5 monthly amount is thought to be sufficient to cover the monthly water charge for PNGWB and still allow some savings for future emergencies. It is recognized that some Committees fix a different water charge for single families, for example, K2.5.

At the beginning of the Project, each Committee was encouraged to open their own bank account and then manage the collected money themselves. However, it is very difficult for private organizations to open their own bank account in PNG, thus PNGWB allows money to be kept in their own deposit account. Although PNGWB decided to grant special treatment to participants of the Pilot Project, the management of collected money is still a pending issue.

ii) The Pilot Project of Daru

In case of Daru, the Water Venders sell water directly to the customers (beneficiaries) and bear overall responsibility related to the Water Vending Unit. They are expected to keep a certain portion of sales from their Water Vending business to pay water charge and future maintenance cost.

In the third field survey, it is observed that the Water Vending business show positive results and the Water Venders and customers (beneficiaries) also convey their positive opinion about this Pilot Project. According to the record of Samari Water Vender, the net monthly profit is around K200 and this amount is thought to be attractive enough as a small enterprise in Daru. The number of beneficiaries is still increasing and the area covered by one Water Vending Unit is also extending more than the expectation of the Study Team.

11.6 Plan for Improving Health and Sanitation

1) Required Consideration for Water Supply and Health Education

Considering present practices related to washing hands after visiting toilets and boiling water, it is obvious that health education should be a high priority. However, learning about these necessities will not be effective until safe, stable, and easily accessible water sources become available.

In addition, considering the different perception of diarrhoea and differing experiences of health education between formal and informal residents/villagers, opportunities for education regarding health and sanitation is necessary in preference to the informal residents/villagers.

2) Required Improvement for Toilet and Sewage

As results of the survey in the Pilot Project show, it is evident that most houses of formal residents are equipped with sewage-related facilities such as kitchens, flush toilets, showers, etc., thus it is not certain if improving these facilities is necessary. However, some households are equipped with pit latrines in addition to flush toilets due to problems surrounding water availability. Furthermore, it is not sure that existing flush toilets are still usable even if water does become available. In the cases of Bereina and Kwikila, where the main water source for formal residents is water tanks, there is a potential risk that the existing sewage system will need to be repaired or an enhanced water supply service will need to be devised because the volume of drainage will increase dramatically.

Table-11.34 Sewage Facilities per Households (average number)

	Kwikila	Bereina	Mutzing
Formal Residents			
Kitchen	0.9	0.8	1.0
Shower	0.9	0.9	0.8
Flush Toilet	0.7	1.0	0.8
Washing Stand	0.8	0.8	0.6
Laundry Stand	0.1	0.2	0.6

As for informal residents/villagers, the spread of sanitation facilities is thought to be a very urgent issue, in particular, in Oro Bay, Bereina and Kupiano, where very few households have sanitation facilities. In order to handle this, not only assistance in targeting facilities is important, but also assistance in targeting the beneficiaries (informal residents/villagers) to improve the awareness of health and sanitation, or training for the construction and maintenance of sanitation facilities. It is not realistic that sanitation facilities for informal residents/villagers can be integrated into the services by PNGWB, therefore co-operation with other organization, like the Department of Health will be required.