THE REPUBLIC OF PALAU
PALAU PUBLIC UTILITIES CORPORATION (PPUC)

THE PREPARATORY SURVEY REPORT
ON
THE PROJECT
FOR
IMPROVEMENT OF WATER SUPPLY SYSTEM

APRIL 2015

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.
NIHON SUIKO SEKKEI CO., LTD.

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Summary

Summary

1. Overview of the Republic of Palau

The Republic of Palau (hereinafter referred to as “Palau”) is an islands-country in the middle western part of Pacific Ocean, and one of the Micronesian countries. Palau consists of 16 states, and the total area of the country is 171mi^2 (444km^2). Palau has a population of about 17,500 (2012) in total, and almost all of the population lives in Koror and Airai States which are the economic center of Palau. Koror State, where 11,665 (2012) persons reside, consists mainly of Koror, Arakabesang and Malakal islands. Airai State, where 2,537 (2012) persons reside, is located in southern edge of Babeldaob island.

2. Background and Outline of the Project

The first water supply system for Koror and Airai States was developed in 1940s under the Japanese Administration. This system was rehabilitated in 1970s during the period of the US Trust Territory. After several improvement projects have been implemented, the current water supply was established. From 1990 to 1992, the water transmission main was constructed by the project of the Japan’s Grant Aid. This project realized the current zoning system with water service tanks.

The current average water supply to Koror and Airai States, where 14,126 people live (2013 estimation), is 3.69MG/day (13,967m^3/day). In both states, the major water distribution pipelines made of Asbestos Cement (hereinafter referred to as “AC”), which were laid in 1940s or 1970s. Although those pipelines have been still utilized for current water supply, they are deteriorated and one of the causes of frequent water leakage. Under these circumstances, average total production per capita is as large as 261G/capita/day (988L/capita/day) and Non-Revenue Water (hereinafter referred to as “NRW”) ratio is estimated approximately 48%.

Water supply is implemented by the Palau Public Utilities Corporation (hereinafter referred to as “PPUC”). Its cost recovery ratio from water and wastewater services is only 40% or less and about 60% of expenditure is subsidized by the Government of Palau (hereinafter referred to as “GoP”). Reduction of water losses is, therefore, one of the urgent issues for PPUC.

In 2009, the action plan of water supply development for 2009 to 2014 was prepared under the assistance of the Asian Development Bank. This plan points out several necessary improvements; such as 1) additional / alternative water sources, 2) improvement / rehabilitation of the existing dam and water intake station, 3) improvement of Koror-Airai Water Treatment Plant (hereinafter referred to as “KAWTP”) and water transmission / distribution system including establishment of Malakal water distribution zone, 4) installation / calibration of water meters, 5) procurement of leak detection equipment, and 6) replacement of water distribution pipes.

Nevertheless the necessary budget has not been secured yet to implement the major improvement / rehabilitation proposed in the above action plan. In 2013, GoP submitted a request of grant aid

assistance to the Government of Japan (hereinafter referred to as “GoJ”) for the important / urgent components. In response to this request, GoP decided to conduct a Preparatory Survey on the Water Supply System Improvement Project (hereinafter referred to as “Project”) and entrusted the survey to the Japan International Cooperation Agency (hereinafter referred to as “JICA”). To confirm and examine the items of the Project, JICA dispatched to Palau the Preparatory Survey Team (hereinafter referred to as “JICA Survey Team”) twice (the first field survey from June 22nd to August 6th, 2014, the second field survey from September 13th to November 6th, 2014). JICA Survey Team conducted field surveys including discussion with the GoP, PPUC and other related agencies about the requested components; implementation of site surveys at the Project sites; and collection of necessary information. In the first survey, JICA Survey Team prepared a “Sector Development Framework”. After examination of the urgency and validity of the requested components with “Sector Development Framework”, JICA Survey Team conducted the draft outline design of the Project in the second survey.

In the process of the Preparatory Survey, three (3) serious issues were confirmed for stable water supply: 1) Insufficient capacity of water transmission, 2) Insufficient service pressure at a hilly area in Koror State, and 3) High NRW ratio due to frequent water leakage.

3. Contents of the Project

In Koror-Airai water supply system, the current water demand on the basis of the daily maximum production comes to approximately 4.0MG/day (15,140m^3/day). It is quite increased in comparison with the design daily maximum production of 2.1MG/day (7,950m^3/day) (target year: 2000) in the previous Japan’s Grant Aid Project (1990-1992). Accordingly, the capacity of water transmission is extremely insufficient. Currently, water is also delivered to some parts of Koror island through the direct water distribution zone around Koror-Babeldaob (hereinafter referred to as “KB”) Bridge. This direct water distribution, which distributes the water directly from water treatment plant without utilization of service tank, ensures hardly the stable water distribution. In November, 2013 and October, 2014, an undersea pipeline was broken in the direct water distribution zone around KB Bridge, and it caused insufficient water supply in Koror and Airai States. The improvement of water transmission / distribution system is, therefore, urgently required.

The current water distribution system is composed of five water distribution zones; Airai water distribution zone, Ngermid water distribution zone, Ngerkesoaol water distribution zone, Arakabesang water distribution zone, and the direct water distribution zone from KAWTP. Among the five (5) water distribution zones, Ngerkesoaol water distribution zone is the largest and covers 65% of the total water distribution. Since the current distribution volume exceeds the capacity of water distribution network, Ngerkesoaol water distribution zone has a low service pressure area (Ngerbeched area), of which pressures are recorded as less than 20psi (0.14MPa). As a countermeasure, it is required to modify the water distribution zones including establishment of Malakal water distribution zone.

NRW ratio reaches 48%, and most of NRW is presumably caused by water leakage. This situation is

inefficient, and energy (electricity) for purification and transmission are wasted. In order to improve this situation (reduce NRW) and to prevent water leakage accidents, the aged water distribution pipelines need to be replaced. Replacement is required for the pipes with the diameter 6in (150mm) or more. The total length of pipelines will be approximately 20.3mi (32.5km). It is, however, not easy to replace all pipelines at once due to construction management. Accordingly, the prioritized pipelines, which will be approximately 8.08mi (12,920m) for total length, will be replaced as the first phase (including lateral pipes).

As the results of field surveys, JICA Survey Team confirmed an urgent need for improvement of water transmission / distribution system in the Project sites, and prepared the draft outline design including the Soft Component plan with consideration of PPUC's capacity of operation and maintenance. This outline design was summarized as the "draft final report", and JICA sent JICA Survey Team in Palau to explain and discuss the contents of the draft final report from February 19th to 28th, 2015.

The following tables show the summary of facilities/equipment plan and the contents of the Soft Component.

Facilities / Equipment Plan

Category	Items	Facility
Construction of Facilities	1. Improvement of Koror-Airai Water Transmission System	1-1 Installation of additional water transmission main from KAWTP up to Ngerkesoaol service tank ➢ L=3.24mi (5,186m), DCIP DN16in (400mm)
	2. Improvement of Water Distribution Networks (Re-arrangement of Water Distribution Zones)	2-1 Installation of exclusive water transmission main for establishment of Malakal water distribution zone ➢ L= 1.93mi (3,094m), DCIP DN10in (250mm)
		2-2 Re-arrangement of water distribution zones (construction of Malakal service tank, Installation of flow meters at each service tank) ➢ Service tank: 1 unit, Capacity: 0.25MG (950m3), RC-made, Rectangle ➢ Flow meter: DN6-8in (150-200mm), 5 units
	3. Improvement of Water Distribution Networks (Replacement of Water Distribution Pipeline)	3-1 Replacement of aged and deteriorated AC pipe ➢ Water distribution pipeline: L=8.08mi (12,920m), PVC DN8-12in (200–300mm) ➢ Lateral connection: 308 units, PVC DN2in (50mm)

Notes: DCIP = Ductile Cast Iron Pipe, DN = Nominal Diameter, RC = Reinforced Concrete, PVC = Polyvinyl Chloride

Contents of Soft Component

Item	Content
Guidance on operation management for water supply and NRW	➢ Management of water transmission/distribution volume and NRW of whole water supply system, and utilization of the acquired data
Guidance on leak detection	➢ Training of leak detection skill and preparation of operation plan for leak detection

4. Implementation schedule and Project cost estimation

If the Project is implemented by the Japan's Grant Aid scheme, the estimated cost for undertakings by the Palauan side is USD 230,820.10 or JPY 25 million. Exchange rate for the cost estimation is

USD1.00 = JPY107.02.

The implementation of the Project is required the time of approximately 29 months, including the detailed design: 3 months, tender procedures: 5 months, preparation, construction, inspection / trial operation: 21 months (including Soft Component: 1 months).

5. Project Evaluation

Relevance of the Project is evaluated as follows.(1) The current water demand (daily maximum production) is approximately 4.0MG/day (15,140m^3/day). Nevertheless, the capacity of existing water transmission facility is extremely insufficient, which is only 2.1MG/day (7,950m^3/day). It is indispensable to increase this capacity.

(2) A hilly area (Ngerbeched area) in Koror Island is a low pressure area, which does not reach the designated minimum dynamic pressure. This area lacks a balance of benefit of water supply. It is highly required to improve the distribution balance and to settle a low service pressure area by re-arrangement of water distribution zones including establishment of Malakal water distribution zone.

(3) NRW ratio reaches 48%, and most of NRW is presumably caused by water leakage. This water leakage wastes energy (electricity) for purification and transmission. It is required to decrease costs for purification and transmission and to improve the efficiency by reduction of NRW ratio. Accordingly it is critically important to replace the aged AC pipes.

The Project site is the economic center of Palau. And a number of foreign visitors is increasing. Under such situation, it is quite important for the economy of Palau to supply water stably to the central part of Koror State and Airai State.

Effectiveness by the Project (target year: 2020) is expected as follows;

Quantitative Effects

Indicator	Baseline (as of year 2013)	Target (3 years after the completion, planned as Year 2020)
Capacity of clear water transmission	2.1MG/day (7,950m^3/day)	4.0 MG/day (15,140m^3/day)
Service Pressure in the Project area*	Less than 2psi (0.014MPa)	More than 20psi (0.14MPa)

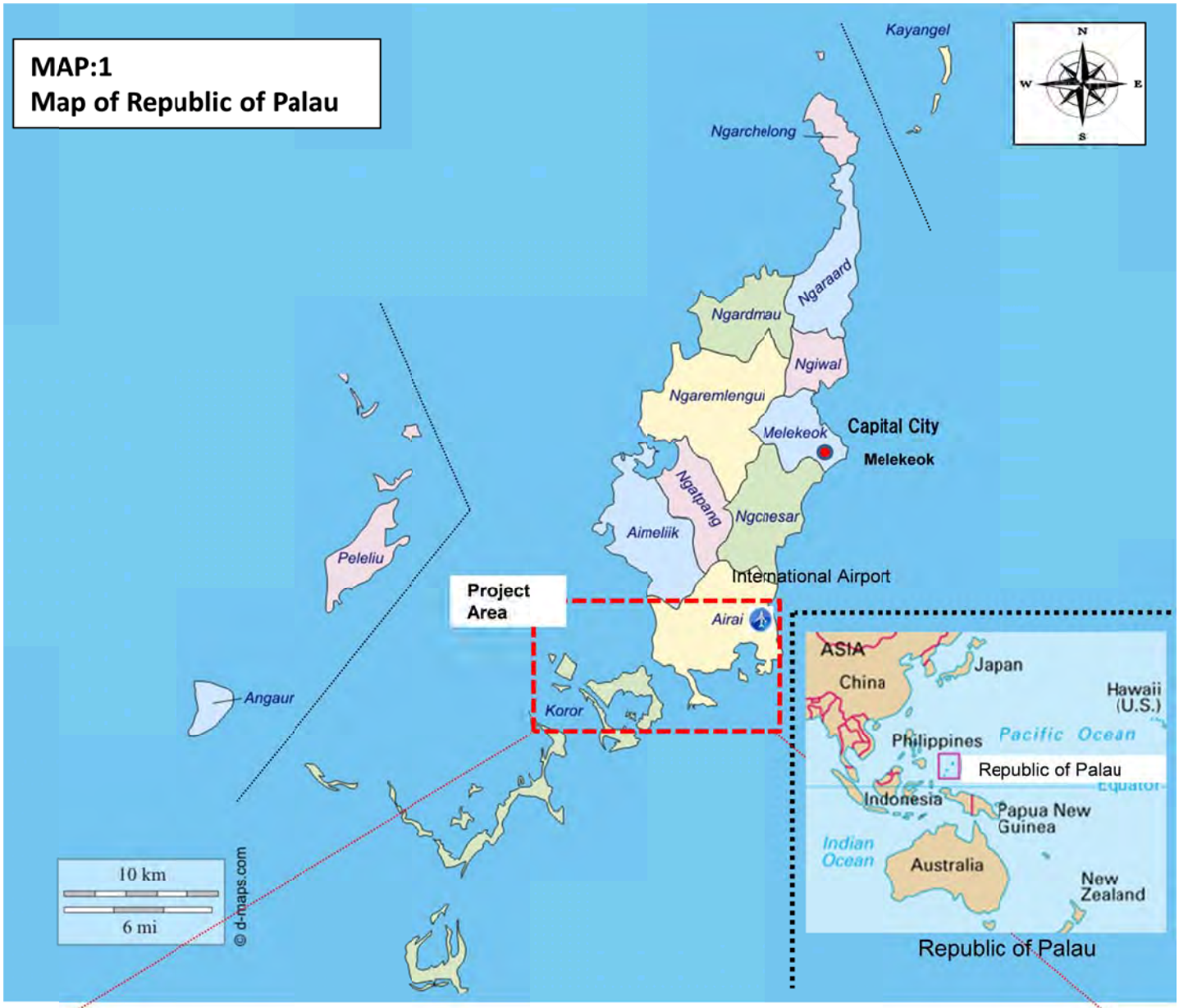
Notes：*Ngerbeched area, the lowest pressure area in the Project area shall be the monitoring area.

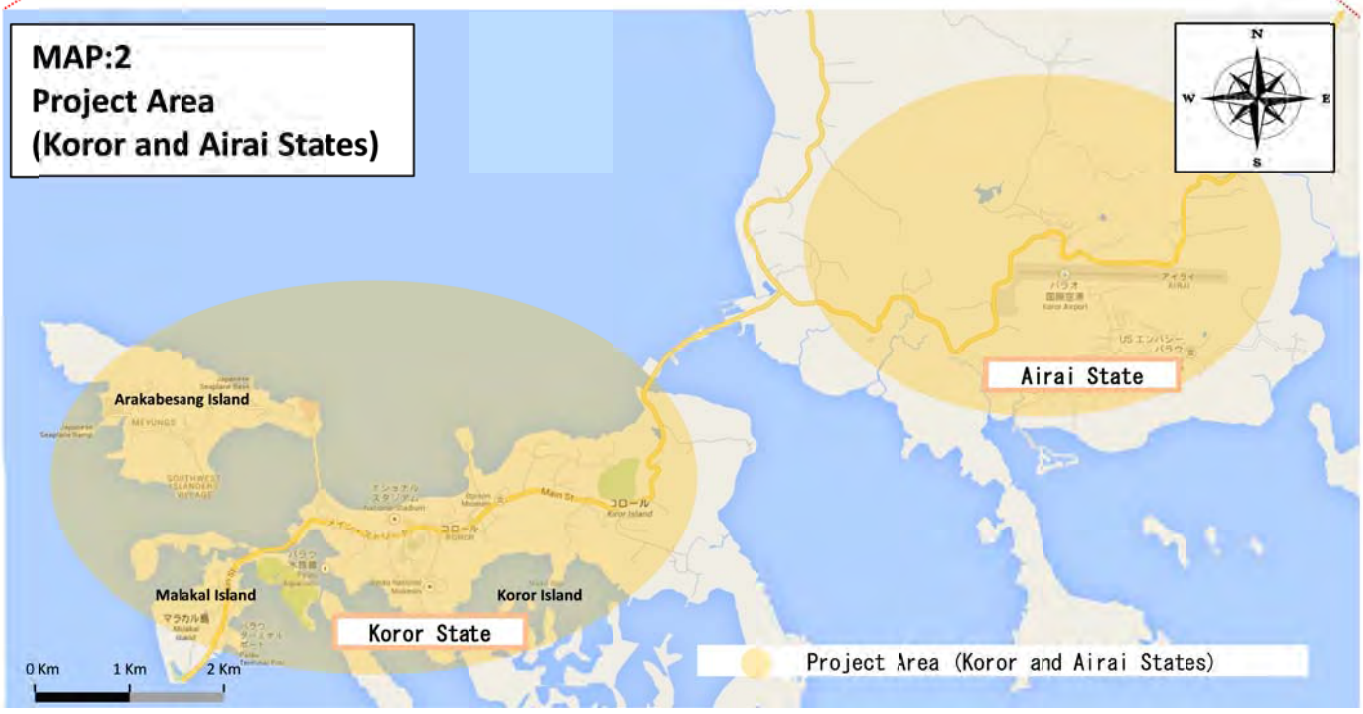
Qualitative Effects

Living environment for the citizens is improved by achieving the stable and even water supply through the Project. Furthermore, leak detection activities and water distribution management become easier to conduct for PPUC by the re-arrangement of water distribution zones.

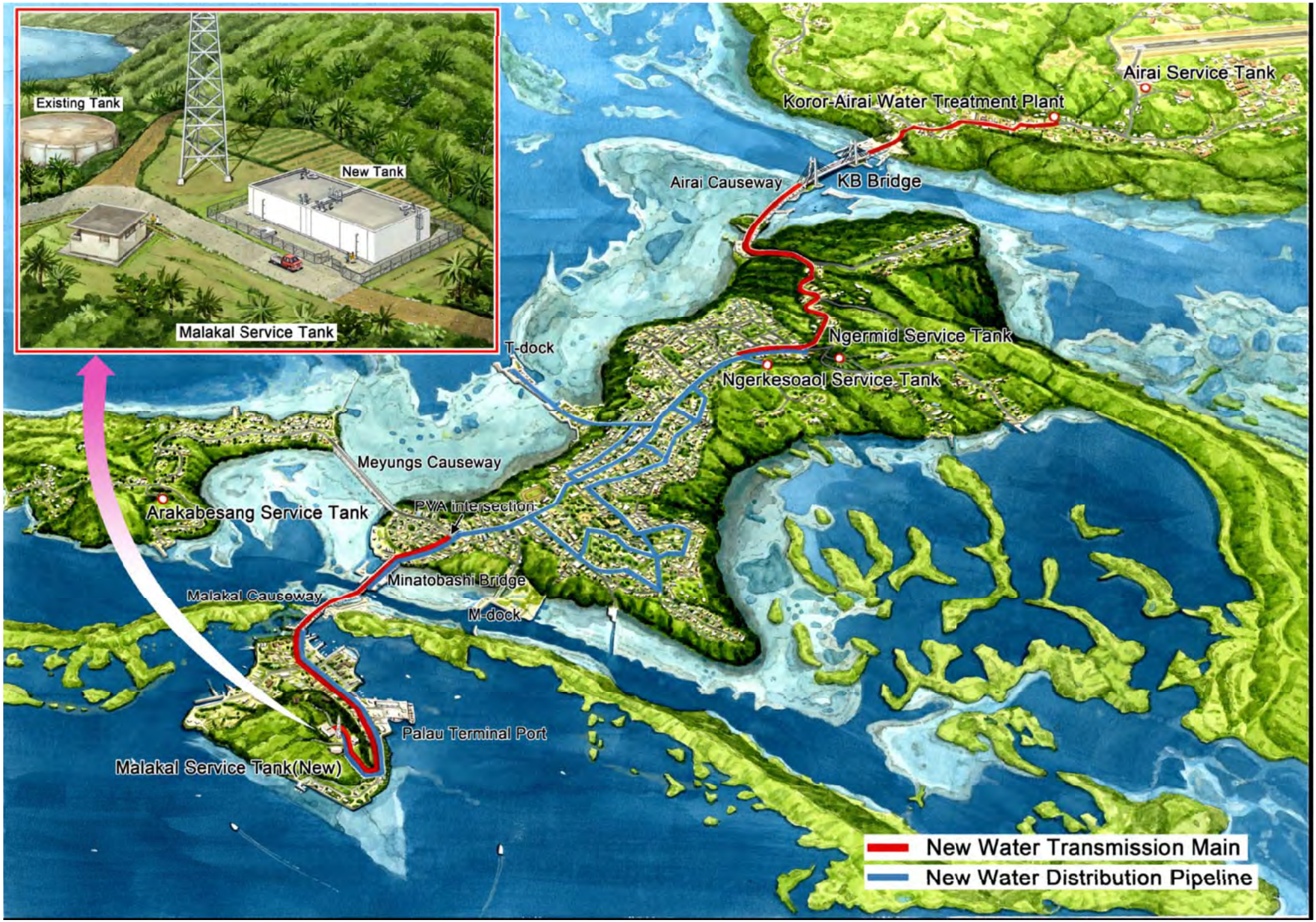
The Preparatory Survey on
Water Supply System Improvement Project
in the Republic of Palau

Contents





Location MAP



Perspective

List of Figures and Tables

Abbreviations

[Organization / Agency]

ADB	Asian Development Bank
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BAC	Bureau of Arts and Culture
BBP	Bureau of Budget & Planning
BLS	Bureau of Land and Survey
BPW	Bureau of Public Works
CIP	Capital Improvement Program
EQPB	Environmental Quality Protection Board
EU	European Union
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JWWA	Japan Water Works Association
KSPLA	Koror State Public Lands Authority
MPIIC	Ministry of Public Infrastructure, Industries and Commerce
NCDC	National Climatic Data Center
ODA	Official Development Assistance
PIF	Pacific Islands Forum
PPUC	Palau Public Utilities Corporation
PVA	Palau Visitors Authority
PWSC	Palau Water and Sewer Corporation
UNDP	United Nations Development Programme
WHO	World Health Organization
WWO	Water and Wastewater Operation

[General]

AC	Asbestos Cement
BP	Booster Pump
CI	Cast-Iron
DCIP	Ductile Cast Iron Pipe
Dia.	Diameter
DN	Nominal Diameter
E/N	Exchange of Notes
EA	Environmental Assessment
EIA	Environmental Impact Assessment

EIS	Environmental Impact Statement
G/A	Grant Agreement
GDP	Gross Domestic Product
GL	Ground Level
GNI	Gross National Income
GS	Galvanized Steel
HDPE	High Density Polyethylene
HWL	High Water Level
IEE	Initial Environmental Examination
KAWTP	Koror-Airai Water Treatment Plant
KB	Koror-Babeldaob
LG	Length
LWL	Low Water Level
NEPA	National Environmental Policy Act
NRW	Non-Revenue Water
O&M	Operation and Maintenance
pH	Potential of Hydrogen
PVC	Poly-Vinyl Chloride
RC	Reinforced Concrete
SCH	Schedule No.
SOP	Standard Operational Procedure
SP	Steel Pipe
SS	Structural Rolled Steel
SUS	Steel Use Stainless
TOR	Terms of Reference

[Unit]

%	percentage
°C	degrees Celsius
°F	degrees Fahrenheit
cm	centimeter
ft	feet
G	gallon
G/min	gallon per minute
HP	horse power
in	inch
km	kilometer
km^2	square kilometer
kW	kilowatt
m	meter

m^3	cubic meter
MG	million gallons
MG/d	million gallons per day
mi	mile
min	minute
mm	millimeter
MPa	megapascal
NTU	nephelometric turbidity unit
psi	pound-force per square inch
rpm	revolution per minute
USD	United States Dollar

Unit Conversion

1mi = 1.6km

1ft = 30cm

1in = 2.5cm

1G = 3.785L

1Pa = $1N/m^2$

1psi = 6.895kPa

Currency Conversion Rate

USD 1.00 = JPY 119.64
(As of April 2015)

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 Background and Outline of the Project

1-1-1 Introduction

Koror and Airai States are the economic centers for the Republic of Palau (hereinafter referred to as "Palau"). The current average water supply in these States is 3.69MG/d (13,967m^3/d) for 14,126 persons, which is the estimated population for 2013. In both states, the major water distribution pipelines were laid about 80 years ago under the Japanese Administration and about 40 years ago during the period of the US Trust Territory. The pipes for the mentioned pipelines are made of Asbestos Cement (hereinafter referred to as "AC"), which strength of the mechanical properties is low. Although those pipelines have been still utilized for current water supply, they are deteriorated and supposed to be causes for large volume of water leakage. Under such circumstances, average total production per capita is as large as 261G/capita/day (988L/capita/day) and Non-Revenue Water (hereinafter referred to as "NRW") ratio is estimated at 48%.

Water supply is implemented by the Palau Public Utilities Corporation (hereinafter referred to as "PPUC"). A large volume of water loss leads the high operation cost for water supply of PPUC, including electricity cost for water transmission pumps. This is one of reasons of the low cost recovery ratio of PPUC, which is only 40% or less. Consequently, approximately 60% of expenditure is subsidized by the Government of Palau (hereinafter referred to as "GoP").

There are some areas suffering from low service pressure in Koror State although the system produces and distributes enough water. Regarding clear water transmission, the capacity of water transmission main is insufficient for the water demand, under design calculation bases. Accordingly, PPUC is not able to assure a stable water supply for the citizens. Moreover, inappropriate and insufficient water transmission / distribution systems cause a low service pressure in Malakal island, which is located far from Koror-Airai Water Treatment Plant (hereinafter referred to as "KAWTP").

In the circumstances, the action plan for 2009 to 2014 was prepared under assistance of the Asian Development Bank (hereinafter referred to as "ADB"). It points out improvements as follows:

- Development of additional / alternative water resources for the draught
- Improvement / rehabilitation of the existing dam and water intake station
- Promotion of public awareness contributing to water conservation
- Improvement of Koror-Airai water supply system (improvement of KAWTP, service tanks, and water transmission / distribution system in Malakal)
- Installation / calibration of water meters
- Equipment procurement and training for leak detection
- Replacement of distribution pipes

Nevertheless, the necessary budget has not been secured yet to implement the major improvement and rehabilitation components. Therefore, GoP requested the Government of Japan (hereinafter referred to as "GoJ") to implement Japan's Grant Aid for the important and urgent components in 2013. In response to this request, GoP decided to conduct a Preparatory Survey on the Water Supply System Improvement Project (hereinafter referred to as "Project") and entrusted the survey to the Japan International Cooperation Agency (hereinafter referred to as "JICA"). JICA dispatched to Palau the Preparatory Survey Team (hereinafter referred to as "JICA Survey Team") to confirm the items of the Project through discussions and field surveys.

1-1-2 Purposes of the Project

In the above-mentioned action plan, PPUC plans: 1) to improve water supply service for reliability and quality through rehabilitation of the aged and deteriorated facilities, and 2) to reduce water production through reduction of high water consumption and NRW. In the process of this Preparatory Survey, three (3) serious issues were confirmed for stable water supply: 1) Insufficient capacity of water transmission, 2) Insufficient service pressure at several points in Koror State, and 3) High NRW ratio due to frequent water leakage.

In this connection, the purposes of the Project are determined as to ensure stable water transmission for Koror and Airai States at 4.0MG/day (15,140m^3/d) under daily maximum supply basis; to ensure sufficient water service pressure in Koror State at 20psi (0.14MPa) or more.

1-1-3 Requested Components of the Project Confirmed in the First Field Survey

At the first field survey, the Palauan side and JICA Survey Team confirmed the responsible and implementing agencies as follows.

Responsible Agency:	Ministry of Public Infrastructure, Industries and Commerce (hereinafter referred to as "MPIIC")
Implementing Agency:	PPUC

The Palauan side and JICA Survey Team also confirmed the requested components of the Project which aimed to improve Koror-Airai water supply system. The Palauan side and JICA Survey Team agreed to the following process to survey and examine the necessity and relevance of the requested components.

- To survey the present conditions by JICA Survey Team during the first field survey
- To summarize issues based on the results of this survey, and compile basic findings and recommendations as Sector Development Framework
- To have a discussion with the Palauan side again on the prioritized components considering Sector Development Framework

Table 1-1-1 Original Components of the Project Requested by GoP

Category	Items	Requested Facilities / Equipment	Remarks
Construction of Facilities	Improvement of water transmission / distribution system in Malakal	Filtration system for Malakal spring water	
		Rehabilitation of Malakal service tank (sandblasting and painting)	Including water level monitoring system
		Piping to and from Malakal service tank	
		Booster pump to Malakal service tank	
		Road pavement restoration	Only for the pavement which the Project removes
	Improvement of water distribution pipeline (bypass) in the central part of Koror State	Installation of new distribution main	
	Development of alternative (reserve) water sources	Development of new wells	
Procurement of Equipment	Improvement of water distribution pipeline (bypass) in the central part of Koror State	Pipe locator and leak detection equipment	
	Development of alternative (reserve) water sources	Well drilling equipment	
Soft Components	Improvement of water transmission / distribution system in Malakal	Tank analysis and hydraulic analysis of wells	
	Improvement of water distribution pipeline (bypass) in the central part of Koror State	Training for leak detection	
	Development of alternative (reserve) water sources	Training for well drilling	

Source: JICA Survey Team

The items described below are the special notes, which were raised in the discussion on confirming the requested items.

1-1-3-1 Improvement of Small Scale Water Supply System in Babeldaob Island

There are 16 small scale water supply systems in Babeldaob Island. The Palauan side requested to include improvements of the systems in the Project because they were too old to keep the appropriate water quality. Nevertheless, it was difficult to respond to the request due to the following reasons. Finally the Palauan side and JICA Survey Team agreed that the countermeasures would be recommended in Sector Development Framework.

- Considering the Project cost, the cost-effectiveness will not be high (the beneficiary will be a little.) because the population is a little for each service area (numbers of customers are several dozens to a hundred).
- This Project originally aims to improve the urban water supply in Koror and Airai states.

In Babeldaob Island, the surface water is distributed after treatment in most of small scale water supply systems. As mentioned above, these systems are aged and difficult to secure appropriate water quality. Improvement is necessary by other projects for conditions that 1) the distributed water contains E-coli, and 2)turbidity of the distributed water is 10 NTU or more.

1-1-3-2 Early Start of Alternative Water Sources Development in Airai State

In case of El Nino, Palau tends to have little rain. In some cases of El Nino, Palau were in droughts which caused the shortages of water volume for distribution.

El Nino was forecasted in 2014. GoP were taking, accordingly, preparations for the drought and impact on water supply, and requested PPUC to take countermeasures. PPUC, therefore, requested the following items:

- To start the well development earlier as an alternative water source as a prepation for El Nino of 2014
- To drill test wells in Preparatory Survey in order to use them as water sources in case of emergency

JICA Survey Team explained that it is difficult to construct facilities in 2014 because of the procedures of Japan's Grant Aid, and Preparatory Survey did not have the plan of test well drilling. The Palauan side understood and agreed not to include the early drilling of wells in the Project.

1-1-3-3 Rehabilitation of Malakal Service Tank

The Palauan side requested sandblasting and painting of the existing Malakal service tank in the original request. PPUC, however, noticed the following after the survey conducted with JICA Survey Team:

- There were serious rusts and damages in ribs, baseplates, anchor bolts, and so on.
- It was difficult to assure the water resistance and structural strength.
- It is preferable to reconstruct the tank of reinforced concrete (hereinafter referred to as "RC").

JICA Survey Team also recognized that the present conditions are not able to assure the water resistance and structural strength of the tank, and started examination to reconstruct it.

1-1-3-4 Rehabilitation of KAWTP

PPUC recognized that the insufficient transmission capacity and necessity of reduction for water losses including NRW (one of its countermeasures is to replace water distribution / lateral pipes). And they noticed that the countermeasures were prioritized for the mentioned matter.

On the other hand, PPUC recognized further the necessity of water quality assurance and rehabilitation of KAWTP as a result of survey conducted with JICA Survey Team. They evaluated that these components were also prioritized as same as the improvement of transmission capacity and the

reduction of water losses. Accordingly, PPUC requested to include the rehabilitation of KAWTP as a prioritized component although it was not mentioned in the original request document.

JICA Survey Team also noticed that the rehabilitation of KAWTP was necessary. The survey team responded that an optimal plan would be proposed to PPUC for the components of the Project after comprehensive consideration in budget / cost and priority order.

1-1-4 Requested Components of the Project Confirmed in the Second Field Survey

Based on confirmation of the components in the first field survey, JICA Survey Team summarized the results and countermeasures of the survey on present conditions, and prepared a draft Sector Development Framework during the first analysis in Japan. After the commencement of the second field survey, JICA Survey Team explained this draft Sector Development Framework, and discussed with the Palauan side on the examination results concerning prioritized components. Details are described in Chapter 2.

As a result of the discussion, the Palauan side and JICA Survey Team summarized the urgently required actions as described below. And PPUC and the survey team agreed to study the components shown in Table 1-1-2 and Table 1-1-3 for the subjects of the Japan's Grant Aid.

- In the previous Japan's Grant Aid Project (1990-1992: the Project for Improvement of Water Supply System), the water transmission main was installed on the basis of the design daily maximum production of 2.1MG/d (7,950m^3/d) as of the target year, 2000. Nevertheless, the current water demand on the basis of the daily maximum production comes to approximately 4.0MG/day (15,140m^3/d). It is required to be improved immediately.
- Ngerkesoaol water distribution zone covers the largest area including the center of Koror State. It causes the low service pressure areas. Water distribution zones need to be modified comprehensively, in order to reduce the size of Ngerkesoaol water distribution zone and improve the distribution balance. This modification includes the establishment of Malakal water distribution zone (an independent water distribution zone for Malakal island).
- NRW ratio reaches 48%, and it is presumed that most of NRW is caused by water leakage. It is inefficient for water and energy (electricity) for treatment and transmission. In order to improve the situation (reduce NRW), the aged AC pipes should be replaced. Replacement is especially required for the pipelines, of which diameter are 6in (150mm) or more. The total length of the said pipelines is approximately 20.3mi (32.5km). It is, however, not easy to replace all pipelines at once due to construction management. Accordingly, the prioritized pipelines, which is approximately 8.08mi (12,920m) in length, will be replaced as the first phase (including lateral pipes).

Table 1-1-2 Requested Components of the Project after Examination

Category	Items	Facilities
Construction of Facilities	1. Improvement of Koror-Airai Water Transmission System	1-1 Installation of additional water transmission main from KAWTP up to Ngerkesoaol service tank ➢ L=3.39mi (5,416m), DCIP DN16in (400mm)
	2. Improvement of Water Distribution Networks (Re-arrangement of Water Distribution Zones)	2-1 Installation of exclusive water transmission main for establishment of Malakal water distribution zone ➢ L= 1.93mi (3,094m), DCIP DN10in (250mm)
		2-2 Re-arrangement of water distribution zones (construction of Malakal service tank, Installation of flow meters at each service tank) ➢ Service tank: 1 unit, Capacity: 0.25MG (950m^3), RC-made, Rectangle ➢ Flow meter: DN6-8in (150-200mm), 5 units
	3. Improvement of Water Distribution Networks (Replacement of Water Distribution Pipeline)	3-1 Replacement of aged and deteriorated AC pipe ➢ Water distribution pipeline: L=8.08mi (12,920m), PVC DN8-12in (200–300mm) ➢ Lateral connection: 308 units, PVC DN2in (50mm)

Notes: DCIP = Ductile Cast Iron Pipe, DN = Nominal Diameter, RC = Reinforced Concrete, PVC= Polyvinyl Chloride
Source: JICA Survey Team

Table 1-1-3 Contents of the Soft Component of the Project

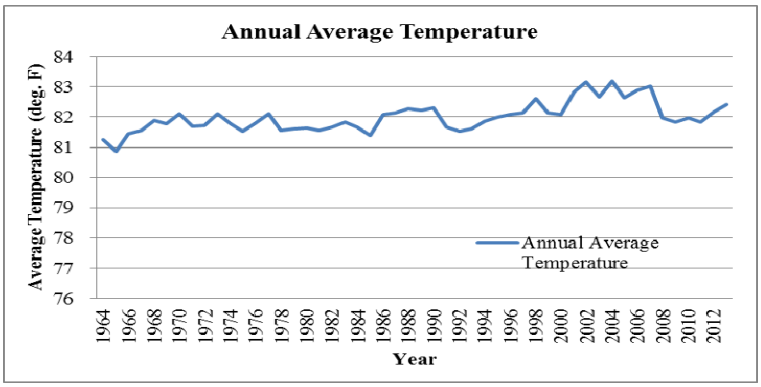
Category	Item	Content
Soft Component	Guidance on operation management for water supply and NRW	➢ Management of water transmission/distribution volume and NRW of whole water supply system, and utilization of the acquired data
	Guidance on leak detection	➢ Training of leak detection skill and preparation of operation plan for leak detection

Notes: NRW = Non-Revenue Water
Source: JICA Survey Team

1-2 Natural Conditions

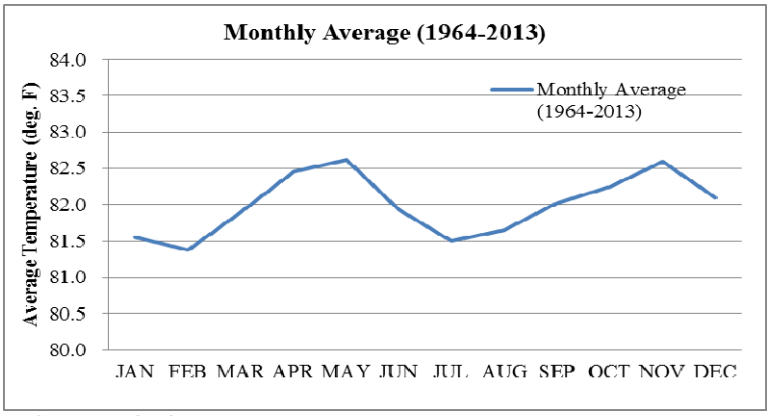
1-2-1 Climate Conditions

Palau is located in a maritime tropical region. The average daily temperature is 82.0ºF (27.8°C) as shown in Figure 1-2-1. The annual average temperature has increased since 1964. It is probably influenced by global warming. The temperature fluctuation by season is relatively small, and the temperature difference in a year is approximately 1.2ºF (0.7°C) as shown in Figure 1-2-2.



Source: National Climatic Data Center (NCDC)

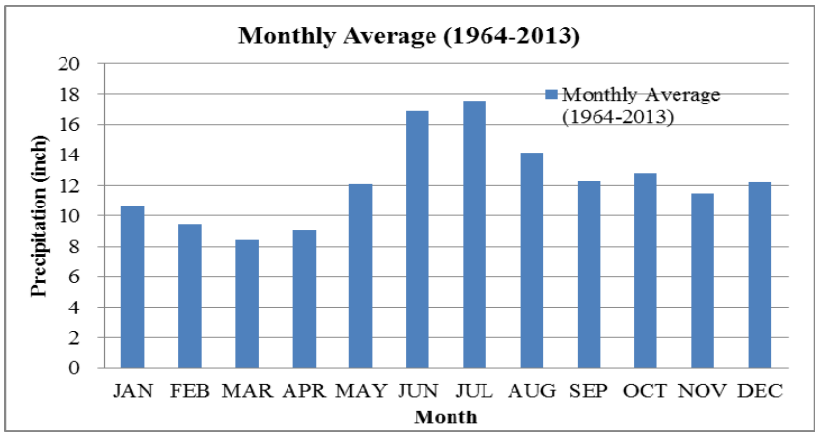
Figure 1-2-1 Annual Average Temperature



Source: NCDC

Figure 1-2-2 Monthly Average Temperature

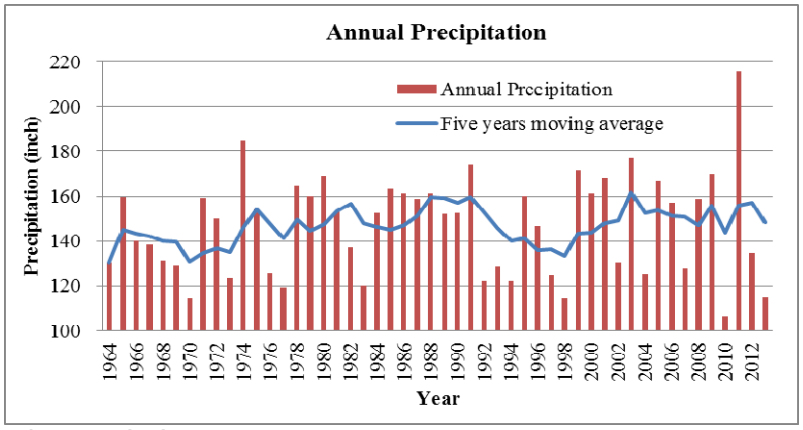
As shown in Figure 1-2-3, precipitation in Palau is heavy throughout a year, especially in July. Precipitation from February to April is relatively small. Nevertheless more than 8.43in (211mm) of precipitation is recorded in March when precipitation is the smallest in a year. Accordingly, the construction schedule should be prepared, considering the heavy precipitation condition.



Source: NCDC

Figure 1-2-3 Monthly Average Precipitation

The annual average precipitation is 147in (3,675mm). As shown in Figure 1-2-4, the fluctuation of annual precipitation is not so small. The precipitation tendency has not been changed since 1964. Moreover, it is recognized that the precipitation was smaller in case of El Nino (such as in 1998 and 2010).



Source: NCDC

Figure 1-2-4 Annual Average Precipitation

1-2-2 Geological Conditions

Koror Island and Babeldaob Island (having Airai State) are volcanic, and their surfaces are covered with a laterite layer. There is no problem for excavation and construction works for these layers.

However, a part of the route for transmission main, which is from Koror-Babeldaob (hereinafter referred to as "KB") Bridge to Ngermid water distribution zone, is covered with limestone. It should be careful to determine construction equipment and methods for excavation of the said pipeline route.

1-3 Environmental and Social Considerations

The Project is one of the improvement projects for urban water supply facilities. There is, however, low possibility that the Project will adversely affect the environmental and social conditions since the main components consist of improvement and rehabilitation of the existing facilities, which are: 1) Installation of additional water transmission main, 2) Installation of exclusive water transmission main and construction of Malakal service tank, and 3) Replacement of aged and deteriorated AC pipe. Environmental category "B" is, therefore, applicable for the Project, based on JICA Guidelines for Environment and Social Considerations (April, 2010).

In Palau, Environmental Quality Protection Board (hereinafter referred to as "EQPB") manages and monitors environmental and social impacts and mitigation activities in Palau.

The following clauses describe the environmental and social considerations and monitoring plans.

1-3-1 Basis of Environmental Conditions and Social Circumstances

(1) Project Site

The Project site is in Koror and Airai States, which have a population of approximately 14 thousands. It is the centers of the economy and tourism of Palau.

In the Project site, the water is currently transmitted through a pipeline of diameter 8 - 16in (200mm - 400mm) from KAWTP to 4 units of the exiting service tanks. The water is distributed from the service tanks for 24 hours by gravity to the residences, commercial facilities, governmental facilities, schools, and so forth.

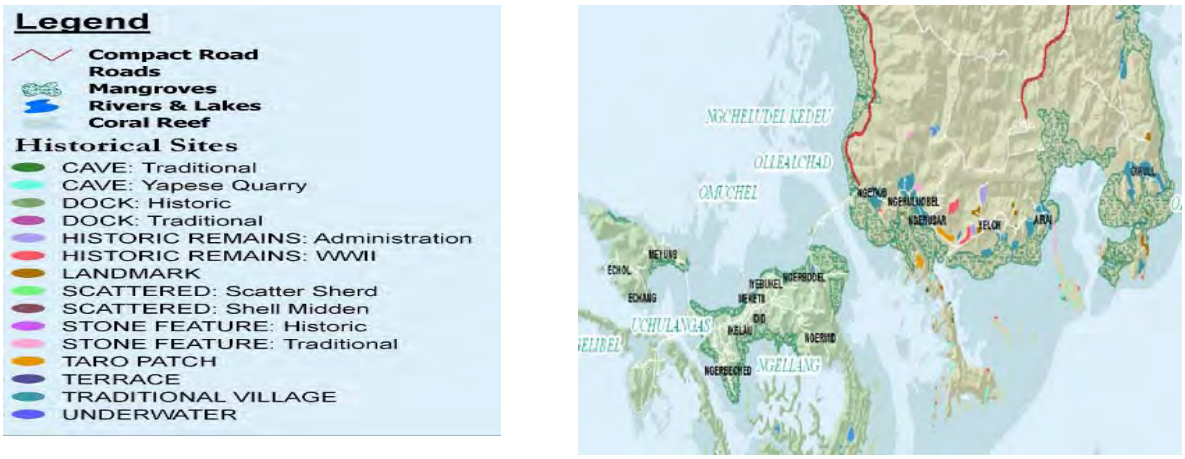
(2) Land Use, Natural Environment and Socio-economic Situation

The conservation areas in Koror and Airai States are shown in Figure 1-3-1. Airai State is rich in nature and has historical heritage along the coastline, making environmental and social considerations necessary for all new development projects. In Koror State, there are coastal mangroves conservation zones, but not protected historical heritages.

The proposed components of the Project in Airai State are the installation of flow meter at the existing service tank and construction of a pipeline (additional water transmission main) under the existing road. The Project activities in Airai State will not affect the conservation areas, and it has no direct relations with the conservation areas. The Project in Koror State consists of laying water transmission main and distribution pipelines along the existing roads, and installing flow meters at the existing service tanks and the proposed Malakal service tank. Only the Malakal service tank needs the land acquisition for construction.

Proposed site for the proposed Malakal service tank is close to the existing service tank. It is unused land, owned by the GoP and managed by Koror State Government. Nevertheless, the farms are spread around the proposed site. It is necessary to remove some parts of the farms before the construction of service tank.

In both Koror and Airai States, the roads have been paved so that the boundaries are relatively clear. Since the roads are wide enough, one lane may be used for the traffic of both directions alternatively during the pipe laying works.



Source: Bureau of Arts & Culture

Figure 1-3-1 Environmental and Social Conservation Areas in Airai and Koror States

1-3-2 Alternative Plans (Including Zero Option)

If zero option is selected for all components of the Project, the problems on current water supply system will not be resolved. In this case, risks for unpredictable water interruption and the low service pressure areas will not be eliminated. When the water is interrupted for a longer time, the economical productivity may decrease and the residents may be forced to buy more bottled water. Since negative impacts are large, the zero option is not recommendable.

On the other hand, the Project is expected to contribute to make the water supply stable. In addition, the Project is to lay new water pipelines along the existing pipelines. Therefore, significant impacts on the environmental and social conditions are not expected. As for Malakal service tank, the land for construction site is owned by GoP, although land acquisition (approval for utilization) is necessary. Implementation of the Project is judged as appropriate because of large and positive impacts.

Table 1-3-1 shows alternatives for the Project components. The contents of the proposed plan are justified as appropriate.

Table 1-3-1 Alternatives for the Project Components (Including Zero Option)

Plan and Alternative		**Contents of the Project Component**	**Situation of Technology, Cost and Environment, etc.**
Alternatives Comparison			
Zero Option to Plan-1		The capacity of the existing water transmission main is insufficient for the demand. The present undersea pipelines and the insufficient capacity are highly risky for sudden broken pipes and interruption of water transmission. Water suspension caused by accidents may influence adversely socio-economic activities as well as living conditions of the residents in Koror and Airai States. It is also predicted that repairing periods become longer for serious cases.	
Plan-1	Additional Water Transmission Main	Additional water transmission main is installed to have enough capacity for demand. The proposed pipeline shall be installed in parallel with the existing pipeline (to be 2 lines).	Environmental impact will be limited since the proposed water transmission main is laid along the existing line.
Alternative 1-1	Alternative for Additional Water Transmission Main	The proposed water transmission main is designed to be in a route different from the exiting one.	1) The other water pipeline route requires additional surveys on topography, land ownership along the route, historical heritage, ecology and ecosystem, etc. 2) If the new route is not along the existing road, access road will be necessary.
Evaluation		From the point of view of technical workability and cost, Plan-1 (pipe laying in parallel to the existing one) is appropriate to minimize the environmental and social impacts.	

Plan and Alternative		Contents of the Project Component	Situation of Technology, Cost and Environment, etc.
Alternatives Comparison			
Zero Option to Plan-2		If the Malakal water distribution zone is not newly established, Malakal island will remain a part of the Ngerkesoaol water distribution zone. In this case, the current low service pressure conditions will not be resolved. Moreover, the imbalance of water distribution and insufficient distribution in some areas will continue.	
Plan-2	Establishment of Malakal Water Distribution Zone and laying Water Transmission Main	To establish Malakal water distribution zone, an exclusive water transmission main and a new service tank shall be constructed.	1) Improvement of the access road is necessary for the new distribution tank. 2) Land acquisition is necessary for Malakal service tank.
		Water transmission main shall be along the existing road.	Although the length of water transmission main is relatively long, no new access road is required.
		Malakal service tank shall be constructed of reinforced concrete.	1) Neighbors are using the Project site for farming. 2) Approval for land utilization is necessary because the land belongs to GoP.
Alternative 2-1	Alternatives for Water Transmission Main	Straight route to a service tank for the exclusive transmission main.	The pipeline will be the shortest in length, but an access road is necessary on the hill side. The cost will be higher.
Alternative 2-2		Installation of high water head pump.	The pumping energy and the electricity cost will increase and the cost of operation and maintenance will be higher.
Alternative 2-3		Installation of booster pump for transmission.	
Evaluation		1) The route of water transmission main will be longer if laid along the existing road, but the construction work will be safer and easier. The maintenance will be also easier. Therefore, the plan along the existing road is appropriate. 2) Malakal service tank should be newly constructed from the view point of durability and water tightness. Considering the insufficient capacity of operation and maintenance of steel structure, a reinforced concrete tank is recommended. As for the land, the proposed site is unused and owned by GoP. The plan to construct a new tank is appropriate to improve the water tightness and workability.	
Zero Option to Plan-3	Improvement of Water Distribution System	Replacement of aged and deteriorated AC pipe.	There are possibilities of asbestos dust scattered during works for AC pipe removal. Measures for prevention of scattered dust and protection of workers are necessary.
Alternative	No other plan	This kind of issue is common for all water distribution lines in Koror and Airai States.	
Evaluation		The replacement of water distribution pipelines is essential for whole water distribution system. Deteriorated AC pipes, which are 50 - 70 years old, are one of the causes of water leakage. The Project plan is effective because the aged pipe replacement will lead to reduction of NRW.	

Source: JICA Survey Team

1-3-3 Environmental and Social Considerations

Considering nature, capacity and characteristics of the proposed facilities and site conditions, scoping was conducted in accordance with JICA Guideline for Environmental and Social Considerations (April, 2010).

The Project will have, in general, positive impacts by making the water supply stable. On the other hand, according to the result of initial scoping for environmental and social impacts, the Project could cause adverse impacts on air pollution, water pollution, waste, soil contamination, noise/vibration, resettlement, uneven distribution of damage and benefits, social infrastructure and social services, and accident.

Further examination was carried out for the mentioned items that negative impacts were anticipated. Consequently, it was evaluated that these negative impacts were limited at the Project site and could be minimized by application of ordinal mitigation measures.

The results of scoping and initial examination are summarized in Table 1-3-2.

Table 1-3-2 Scoping and Survey Results

Classi-fication	No.	Item	Impact Evaluation Based on Scoping		Impact Evaluation Based on Surveys		Remarks
			Before and During Construction	Operation Stage	Before and During Construction	Operation Stage	
Pollution	1	Air Pollution	B-	D	B-	D	**Before and During Construction:** Exhaust gas and dusts are generated by operation of construction vehicles and machineries. Nevertheless, it is minimized by sprinkling water and by using smaller equipment. The exhaust gas is regulated by energy saving measures such as idling-stop of engine. **During Operation:** The pump utilizes commercial electricity power. Therefore, there is no exhaust gas emission.
	2	Water Pollution	C-	D	D	D	**Before and During Construction:** Rainwater generates the turbid water in excavated trenches / pits. To reduce turbid water, a tentative cover is installed over the trenches / pits. Accordingly, the impact can be minimized. **During Operation**: Domestic wastewater flow is not increased dramatically even if water supply is improved by the Project. Accordingly, no water pollution impact is anticipated.
	3	Waste	C-	D	D	D	**During Construction**: The surplus soil and construction waste will be disposed properly by the Contractor at the proper landfill site. **During Operation**: Sludge generated in KAWTP will be dried in the plant yard (about 1ton/d of dewatered cakes). Since there are landfill sites at Koror and Airai States, the waste / dewater cakes will be disposed properly.
	4	Soil Contamination	C-	D	D	D	**Before and During Construction:** Asbestos waste of the abandoned pipes will be generated. No pollutant will be, however, scatted since the abandoned pipes will be left as they are. Construction methods will be selected to protect workers against asbestos. As the asbestos is chemically stable, no elution is anticipated. **During Operation**: Chemical pollutant will not be discharged from water supply facilities.

Classi-fication	No.	Item	Impact Evaluation Based on Scoping		Impact Evaluation Based on Surveys		Remarks
			Before and During Construction	Operation Stage	Before and During Construction	Operation Stage	
Pollution	5	Noise and Vibration	B-	D	B-	D	**During Construction**: Noise/vibration will be generated by construction works. Nevertheless, the Contractor will take necessary measures against the noise / vibration such as fencing, using low noise machinery, and managing working hours. In addition, the Contractor will monitor noise / vibration during construction works. **During Operation**: Since the facilities are operated by commercial electricity power, noise / vibration will not be generated.
	6	Land Subsidence	D	D	D	D	Since no groundwater use is planned, no land subsidence due to groundwater use is anticipated.
	7	Odor	D	D	D	D	There will not be any works related to odor.
	8	Sediment	D	D	D	D	No disturbance of the bottom of the water intake facility is anticipated.
Natural Environ-ment Social Environ-ment	9	Protected Areas	D	D	D	D	There will not be any works close to the protected areas.
	10	Ecosystem	D	D	D	D	No work that may affect the ecosystem is planned in the Project.
	11	Weather	D	D	D	D	No work that may affect the weather system is planned in the Project.
	12	Topography & Geology	D	D	D	D	The Project will not adversely affect the topography and geology.
	13	Resettlement	C-	D	D	D	Although there are illegal farming lands, resettlement will not be necessary.
	14	Poor	D	C+	D	D	Improvement of water access and sanitation is anticipated through the re-arrangement of the water distribution zones.
	15	Ethnic Minority and Indigenous People	D	C+	D	D	There is no ethnic issue that should be considered in the Project.
	16	Local Economy (Employment and Livelihood, etc.)	D	C+	D	D	Positive impact on the hotels and tourists is expected.
	17	Land Use and Regional Resource Use	D	D	D	D	Land for Malakal service tank is proposed and fixed under the cooperation of Koror State Government.
	18	Water Use	D	D	D	D	Water use will be stabilized along with improvement of facilities.

Classi-fication	No.	Item	Impact Evaluation Based on Scoping		Impact Evaluation Based on Surveys		Remarks
			Before and During Construction	Operation Stage	Before and During Construction	Operation Stage	
Natural Environment Social Environment	19	Existing Social Infrastructure and Social Services	C-	C+	C-	C+	**During Construction**: In the short-term, the works will have negative impact on social infrastructure and services (water suspension / road excavation / traffic detour). **During Operation**: Social infrastructure and services will be improved because of the stable water supply.
	20	Social Organization of Decision-Making Institutions for Community and Social Capital	D	D	D	D	There will not be any impacts on social capital and local decision-making institutions.
	21	Uneven Distribution of Damage and Benefits	C-	C+	D	D	**Before and During Construction:** Currently, the residents in low service pressure area do not properly benefit sufficiently from water supply. **During Operation**: Stable water supply will be ensured by the improvement of the water supply facilities. As a result, uneven benefit distribution caused by low service pressure will be improved. In addition, since water meter will be installed, fair water distribution and fair tariff collection are expected. Financial improvement of PPUC is also expected.
	22	Conflicts in the Region	D	D	D	D	There is not any conflicts in the region.
	23	Cultural Heritage	D	D	D	D	There is not any activities related to the cultural heritage in the Project.
	24	Landscape	D	D	D	D	No landscape change is anticipated.
	25	Gender	D	D	D	D	Since house connection has already expanded, it will have little impact on reducing water drawing works of women.
	26	Children's Rights	D	D	D	D	Since house connection has already expanded, it will have little impact on reducing water drawing works of children. Nevertheless, the health of children will improve because of the safe water supply.
	27	Infectious Diseases such as HIV / AIDS	D	C+	D	D	Improvement of health and hygiene is expected through safe water supply.
	28	Working Environment (Including Occupational Safety)	D	D	D	D	Although asbestos cement pipes will be abandoned in the Project, the dust will be prevented by the Contractor. The working method will be selected taking the prevention of the dust scattering into account.

Classi-fication	No.	Item	Impact Evaluation Based on Scoping		Impact Evaluation Based on Surveys		Remarks
			Before and During Construction	Operation Stage	Before and During Construction	Operation Stage	
Others	29	Accident	C-	D	B-	D	**During Construction**: Regular safety management meetings will be held regularly to prevent the traffic accidents that may occur during the work. Speed will be regulated, and appropriate work schedule will be fixed to prevent the accidents. **During Operation**: To prevent traffic accidents, PPUC will pay attentions to vehicles. Safety management is necessary for quotidian works such as site cleaning and vehicle / driver allocation.
	30	Trans Boundary Impacts, and Climate Change	D	D	D	D	There are not any activities that will affect the cross-border waste transportation and climate change in the Project.

A+/-: Significant positive / negative impact is expected.
B+/-: A certain degree of positive / negative impact is expected.
C+/-: The positive / negative impact is unknown. (requires further investigation.)
D：Effect is not expected
Source: JICA Survey Team

1-3-4 Plan for Environmental Monitoring

(1) Environmental Monitoring Plan

Environmental monitoring plan was prepared for necessary environmental management as Table 1-3-3. According to the plan, PPUC will conduct the environmental monitoring during construction / operation.

Table 1-3-3 Monitoring Plan

Time	Classification	Monitoring Item	Point	Frequency	Method	Responsible Institution	Cost
Const-ruction Phase	1. Air Quality	Dust complaints of residents	Construction site and surrounding area	During construction work Once a week and when there is complaint	Visual inspection and interviewing residents	Contractor PPUC	Included in the construction cost
	2. Noise and Vibration	Complaints of residents Reference value: noise / vibration regulation laws of Japan Noise: 85db Vibration: 75db	Construction site and surrounding area	During construction work Once a week and when there is complaint	Confirmed by measurement and interviewing residents	Contractor PPUC	Included in the construction cost
	3. Water Quality	Turbid water Reference value: water pollution control law of Japan SS: average 150mg / L (Maximum 200mg / L)	Drains near excavation site	During construction work Once a week and on rainy days	Confirmed by measurement and photographic records	Contractor PPUC	Included in the construction cost

Time	Classification	Monitoring Item	Point	Frequency	Method	Responsible Institution	Cost
Const-ruction Phase	4. Existing Social Infrastructure and Social Services	Traffic control, pre-notice of water suspension	Construction site and surrounding area Site office	When necessary during construction period	Visual check (by monitoring tour) Photographic records Monthly work report	Contractor PPUC	Included in the construction cost
	5. Accident	Accidents prevention measures, safety education	Construction site Site office	When necessary during construction period	Visual check (by monitoring tour) Photographic records Monthly work report	Contractor PPUC	Included in the construction cost
Opera-tion Phase	1. Existing Social Infrastructure and Social Services	Adequate water supply flow and water pressure Distribution pressure: Management value of PPUC 20psi (0.14MPa)	Sample households in benefit areas	Once a month	Confirmed by measurement, measurement records	PPUC	PPUC Maintenance cost

Source: JICA Survey Team

(2) Monitoring Form

The monitoring form proposed to PPUC is shown in Attachment-16.

1-3-5 Stakeholders Meetings

- **July 18, 2014:** PPUC and JICA Survey Team conducted a survey related to the land use. PPUC and JICA Survey Team obtained the information from the Koror State Government that the public land would be able to be utilized for public water supply projects if official application and examination would be done properly.
- **September-December 2014:** Prior to topographic survey and soil investigation for Malakal service tank, Koror State Government explained “the construction plan for water facilities and the commencement of land surveys” to the farmers using the Project site for farming. The farmers agreed on removal of the crops from the necessary parts and allowed JICA Survey Team to enter the farming land for the surveys. The farmers agreed it voluntarily and no request was issued for compensation.
- **October, 2014:** PPUC requested the Koror State Government to issue the land approval for the proposed Malakal service tank. PPUC discussed land allocation with Koror State Government.
- **September-November, 2014:** The proposed water transmission main is along the national road for Airai - Koror - Malakal islands. Since the pipe laying work includes excavations of the paved road, discussions with the Bureau of Public Work (hereinafter referred to as “BPW”) were conducted for excavation width / depth and re-pavement.
- **September-October, 2014:** Confirmation meeting were conducted with EQPB and the Ministry of Public Infrastructure, Industries and Commerce (hereinafter referred to as “MPIIC”) on the disposal of abandoned AC pipes to be generated by the replacement of water distribution pipelines. It was agreed to leave the pipes as they were at the same location (not to take them out from the excavation sites), and to backfill the trenches.

1-3-6 Land Acquisition and Resettlement

To construct the Malakal service tank, PPUC should acquire a necessary space of land. The proposed land is unused, owned by GoP and managed by Koror State Government. PPUC have discussed the land allocation with Koror State Government, and it was approved in February 2015.

No resettlement was required in the process of the mentioned land acquisition. Removal of some farms is, however, necessary. Presently, neighboring residents are utilizing a part of the land for farming. The farm will be removed by Koror State and PPUC through stakeholders meeting before commencement of the Project.

1-3-7 Asbestos Cement Pipe

Most of the exiting water distribution pipelines are made of AC. Since the Project includes the replacement of the water distribution pipelines, the exiting AC pipes will be abandoned along with replacement progress.

On the other hand, there is no asbestos waste disposal site in Palau. The largest landfill site in Palau, which is M-dock landfill site operated by MPIIC, has also no management capacity for hazardous waste. Therefore, MPIIC does not allow the disposal of AC pipe in M-dock landfill site.

In these circumstances, EQPB and MPIIC request the following:

- To prevent the scattering of dust, the abandoned AC pipes should not be taken out from the original locations.
- The abandoned AC pipes should be left as they are in the trenches and the excavated trenches should be back-filled.
- When cutting some parts of AC pipe is necessary, the cut-out pipe should not be also taken out from the trench and should be buried near the original location.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

The Project purpose is that living environment for the citizens is improved by achieving the stable and even water supply according to improvement of water transmission main, re-arrangement of distribution zones, and replacement of water distribution pipelines in Koror and Airai States.

In order to contribute to achievement of the Project purposes, the Project provides 1) Installation of an additional water transmission main, 2) Establishment of Malakal water distribution zone and re-arrangement of water distribution zones, and 3) Replacement of water distribution pipelines of about 8.08mi (12,920m) which is approximately 40% of principal water distribution pipelines.
The facilities shown in Table 2-1-1 will be constructed / rehabilitated by the Project. Moreover, "Soft Component" will be conducted in parallel with the construction / rehabilitation as shown in Table 2-1-2.

Table 2-1-1 Components of the Project (Facilities and Specifications)

Category	Items	Facilities
Construction of Facilities	1. Improvement of Koror-Airai Water Transmission System	1-1 Installation of additional water transmission main from KAWTP up to Ngerkesoaol service tank ➢ L=3.39mi (5,416m), DCIP DN16in (400mm)
	2. Improvement of Water Distribution Networks (Re-arrangement of Water Distribution Zones)	2-1 Installation of exclusive water transmission main for establishment of Malakal water distribution zone ➢ L=1.93mi (3,094m), DCIP DN10in (250mm)
		2-2 Re-arrangement of water distribution zones (construction of Malakal service tank, Installation of flow meters at each service tank) ➢ Service tank: 1 unit, Capacity: 0.25MG (950m^3), RC-made, Rectangle ➢ Flow meter: DN6-8in (150-200mm), 5 units
	3. Improvement of Water Distribution Networks (Replacement of Water Distribution Pipeline)	3-1 Replacement of aged and deteriorated AC pipe ➢ Water distribution pipeline: L=8.08mi (12,920m), PVC DN8-12in (200–300mm) ➢ Lateral connection: 308 units, PVC DN2in (50mm)

Notes: DCIP = Ductile Cast Iron Pipe, DN = Nominal Diameter, RC = Reinforced Concrete, PVC = Polyvinyl Chloride
Source: JICA Survey Team

Table 2-1-2 Contents of the Soft Component of the Project

Item	Content
Guidance on operation management for water supply and NRW	➢ Management of water transmission/distribution volume and NRW of whole water supply system, and utilization of the acquired data
Guidance on leak detection	➢ Training of leak detection skill and preparation of operation plan for leak detection

Notes: NRW = Non-Revenue Water
Source: JICA Survey Team

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

The basic policy of the Project is to improve water transmission / distribution facilities for stable water transmission, elimination of low service pressures areas, and reduction of NRW.

To secure the sufficient capacity for water transmission, the Project provides an additional water transmission main (to be two pipelines systems). The current water demand (maximum production per day) in Koror-Airai water supply system is approximately 4.0MG/day (15,140m^3/day). This figure much exceeds the planned demand (target year: 2000) for 2.1MG/day (7,950m^3/day) which has been set in the previous Japan's Grant Aid Project. The capacity is, therefore, extremely insufficient for water transmission main. Currently, water is also delivered to some parts of Koror Island through the

direct water distribution zone around KB Bridge. This direct water distribution, which distributes the water directly from water treatment plant without utilization of service tank, ensures hardly the stable water transmission / distribution. In November, 2013 and October, 2014, an undersea pipeline was broken in the direct water distribution zone around KB Bridge, and it caused insufficient water supply in Koror and Airai States. The improvement of water transmission system is, therefore, urgently required.

The Project proposes to provide Malakal service tank and an exclusive transmission main to the tank. It will realize establishment of Malakal water distribution zone and contribute to area reduction of Ngerkesoaol water distribution zone. Among the five (5) water distribution zones, Ngerkesoaol water distribution zone is the largest and covers 65% of the total water distribution. Since the current distribution volume exceeds the capacity of water distribution network, Ngerkesoaol water distribution zone has a low service pressure area, of which pressures are less than 20psi (0.14MPa). As a countermeasure, modifications of water distribution zones are required.

To improve efficiencies in water and energy for water transmission / distribution, the Project replaces the aged and deteriorated distribution pipelines for a length of 8.08mi (12,920m). It is assumed that most of NRW, which ratio is 48% in Koror-Airai water supply system, is caused by leakage. That is to say, the system is inefficient in water and energy for water transmission / distribution. To improve the efficiency (NRW reduction) and to prevent leakage accidents, replacements of aged and deteriorated AC pipes are proposed for the major water distribution pipelines. A total length of approximately 20.3mi (32.5km) of the network should be replaced for pipelines with a diameter of 6in (150mm) or more. It is, however, not easy to replace all pipelines at once due to difficulty of traffic management and construction schedule. The replacement of 8.08mi (12,920m) long pipeline, which includes lateral pipes up to the private premise boundary, will be conducted in the Project as the first phase replacement.

The original request of GoP includes development of additional / alternative water source for drought. The drought occurred twice in 30 years, which is in the allowable frequency range regulated by the Japanese guideline for water facilities designs (maximum frequency of the range: once a decade). Accordingly additional / alternative water sources does not need to be developed urgently. It is, therefore, not included in components of the Project.

2-2-1-2 Natural Environmental Conditions

Palau is located in a maritime tropical region. The average temperature is approximately 82.0ºF (28.0°C). The seasonal fluctuation of the temperature is relatively small. The mean humidity is also as high as 80%. These temperature and humidity, however, are somewhat softened by the trade wind and rain squalls. Precipitation is heavy throughout the year, and the annual average is approximately 152in (3,800mm). The large precipitation is recorded in May to September, but there is not clear classification of the rainy season. Moreover, high intensity of rainfall is often observed. Although typhoons develop all the year round, large-scale typhoons rarely approach in Palau since it is close to the source of typhoons.

Surface soil is generally the laterite (cohesive soil), which is weathered basalt. When it contains water, it will be fluidized, and drainage and de-watering will be difficult. A prevention measure from rainwater in-flowing into a trench should be undertaken. Soil conditions for a part between KB Bridge and Ngermid service tank, however, are in limestone which originates in the upheaval of a coral reef. In the mentioned part, special measures should be taken in excavation for rock breaking.

2-2-1-3 Socio-economic Conditions

It is not necessary in general for the Palauan side to acquire newly lands for facilities to be constructed since most of the facilities are pipelines to be installed under the existing road. Nevertheless, in case of the proposed Malakal service tank, it is necessary for PPUC to secure newly the land.

Palauan citizens are generally sensitive toward land issues, and using private land for construction may sometimes cause disputes for rights of ownership. In case of the proposed Malakal service tank, it is not necessary to buy a new plot. The proposed site belongs to GoP, and Koror State Public Lands

Authority (hereinafter referred to as “KSPLA”) has already issued an approval on the land utilization for the proposed Malakal service tank.

The site around the proposed Malakal service tank is utilized as a farm land. This farm should be removed before facility construction. Regarding this issue, the Koror State will discuss the amicable removal with farmers. In the outline design stage, entering the farm and removal of some parts of the farm were allowed by the farmers for topographic survey and soil investigation according to consultation of the Koror State. It is expected that the amicable removal be possible.

2-2-1-4 Construction and Procurement Conditions and/or Commercial Practice

Most of the construction materials are imported into Palau, except aggregates, cement, forms and ready-mixed concrete. The materials are usually imported from the Philippines, Japan, Taiwan, and the United States. It is, therefore, necessary to consider the third countries (such as the Philippines and the United States) as material sources, adding to Japan and Palau. In case of planning procurement in the third countries, thorough investigation is required for price, quality, delivery period, easiness of procuring spare parts for the operation and maintenance (hereinafter referred to as “O&M”) stage, and consistency with the existing facilities and equipment.

Regarding construction machines and vehicles, local construction companies are able to provide them. Most of the construction machines are, therefore, able to be procured locally. Nevertheless, if special equipment is necessary, the Project should examine to procure in Japan or the third countries.

Regarding arrangement of engineers and workers, it depends on foreign workers from the Philippines and other countries since the population is a little in Palau. The foreign workers contribute to various industries in Palau, and it is possible to secure the foreign workers through the local contractors. On the other hand, it is difficult to secure specialized and/or management engineers in Palau, including skilled and specialized workers. In order to secure the appropriate engineers / workers in Palau, it is necessary to dispatch them from Japan or other countries. Consequently, it can enable to realize proper quality management, technical guidance and construction supervision.

2-2-1-5 Utilization of Local Companies (Construction / Consultant)

In Palau, there are several local construction companies, and it is comparatively easy for them to arrange workers, construction vehicles and equipment. It means the Project can easily arrange general workers or procure general materials for the water distribution facilities.

A local construction company was utilized as subcontractor in the case of power plant construction which was conducted by the Japan’s Grant Aid in 2012. The local contractor performed sufficiently the roles in construction.

The Project will, therefore, also utilize local contractors, mainly for a field of procurement of construction equipment and workers.

Nevertheless, for the purpose of quality, schedule and safety control, it is necessary to dispatch engineers from Japan.

In Palau, there are three (3) companies for ready-mixed concrete. They provide the concrete stably and deliver the concrete to construction sites by concrete mixer trucks.

To plan schedule of the Project, the regular working hours in Palau should be taken into account. The regular working hours of public authorities in Palau are as follows:

- Regular working hours : 8 hours / day (7:30–16:30, including 1 hour for lunch), 40 hours / week
- Holiday : Saturday / Sunday
- Public Holiday : 8 days / year
- Notes : Actual weekly working hours on construction sites are 48 hours / week, one day off in a week.

2-2-1-6 Operation and Maintenance Capability of Implementing Agency

PPUC is organized with two (2) departments for technical field, namely, the Power Operation and the Water and Wastewater Operation (hereinafter referred to as "WWO"). O&M services of the facilities are conducted separately by each department. The Power Operation Department covers its cost with the tariff income of electricity charges. Nevertheless, it is difficult for WWO to sustain the services by the tariff income of the water and wastewater charges. The cost recovery ratio of WWO, which is defined by revenue per expenditure, is 38%. It is in a deficit condition. Since the funds cannot be diverted between the two (2) sections, the profit of the Power Operation Department is not able to be allocated to WWO. WWO is, therefore, required to be more efficient and to improve the tariff system.

Regarding the tariff system, PPUC is improving it gradually along with the recommendations by ADB. Although PPUC is able to revise the tariff by itself, the tariff improvement could not be realized easily due to political reasons. A practical issue before increasing price of tariff is to improve the service level of water supply, especially for Outlying States.

The main issues requiring optimization are to reduce NRW, and to re-arrange the staff members according to service scales. NRW reduction is closely related to the Project. Through a training provided by the Project (such as the Soft Component), the O&M staff members for pipelines and KAWTP will manage water distribution and reduce NRW more efficiently. Additional sections and staff members are basically unnecessary. Approximately three (3) staff members are, however, to be shifted from the neighboring states in Babeldaob Island if the existing O&M works are influenced by the planned activities for water distribution management and NRW reduction.

The number of staff members and their skills for water distribution management and water leak detection are not sufficient to implement the Project. In parallel to construction of facilities, it is necessary to develop the capacity for the mentioned fields, as well as to procure the equipment and implement skill trainings. The facility construction should be implemented along with other technical cooperation such as the Soft Component.

2-2-1-7 Grade Setting of Facilities and Equipment

PPUC has conducted water conveyance and transmission through the pumping system. Water distribution is, however, managed by the gravity system which is an energy-saving system without pumping power. This gravity system also will be adopted in the Project for the water distribution.

Water level of the existing service tanks is manually managed by valve control based on the transmitted data for the water level from the monitoring system. Same water monitoring system is to be applied to the proposed Malakal service tank for an integrated management system of water levels.

2-2-1-8 Construction & Procurement Methods and Construction Schedule

Construction and procurement methods and schedule are planned as follows:

- The location of pipe laying work is along the main road so that construction work shall be planned to avoid inconvenience to pedestrians and vehicles as much as possible.
- Regarding the pipe laying work, part of subsurface soil is in rock (limestone). Construction period and cost should be estimated according to results of the test pit survey for the assumed rock situations.
- Basically, standards of International Organization for Standardization (hereinafter referred to as "ISO") will be applied in the Project. In case of difficulty for management in material procurement, Japanese Industrial Standards (hereinafter referred to as "JIS") and other technical standards for Japan Water Works Association (hereinafter referred to as "JWWA"), American National Standards Institute (hereinafter referred to as "ANSI") and American Water Works Association (hereinafter referred to as "AWWA") will be applied for design.
- The whole construction period from the detailed design to the completion of the Project is planned as 29 months from the signing of Exchanges of Notes (hereinafter referred to as "E/N").

2-2-2 Basic Plan (Construction / Equipment Plan)

2-2-2-1 Planning Fundamental

Design parameters for the Project are as shown in Table 2-2-1.

Table 2-2-1 Design Parameters for the Project

Item	Unit	Design	Applied Facilities	Remarks	
Design equivalent service population[*1]	capita	15,466		Refer to Section 2-2-2-1(4) 6), target year of 2020	A
Design per capita water supply[*2]	G/capita/day (L/capita/day)	200 (757)		Refer to Section 2-2-2-1(4) 6), target year of 2020	B
Design maximum daily coefficient[*3]	-	1.07		Refer to Section 2-2-2-1(4) 6)	C
Design load factor[*3]	-	0.93		Refer to Section 2-2-2-1(4) 6)	$D=C^{-1}$
Design maximum daily water supply [*4]	MG/day (m^3/day)	4.0 (15,140)	Service tank capacity, Diameter of water transmission pipelines	Refer to Section 2-2-2-1(4) 6) Current maximum daily water supply volume (year 2014)	E
Design maximum hourly coefficient	-	1.3		Refer to Section 2-2-2-5(2)	F
Design maximum hourly water distribution	MG/day (m^3/day)	5.2 (19,682)	Diameter of water distribution pipelines	—	G=E x F
Design dynamic water pressure (lowest)	psi (MPa)	20 (0.14)	Diameter of water distribution pipelines	Dynamic water pressure at branch of distribution pipelines to service pipelines	H
Service Tank Capacity	MG (m^3)	0.25 (950)	Malakal service tank	Twelve (12) hour-storage of design maximum daily water supply plus water distribution volume for fire fighting	I

Notes: 1) Design equivalent service population is the service population including foreign visitors.
2) Design per capita water supply includes non-domestic consumption and foreign visitors consumption.
3) Design maximum daily coefficient of 1.07 is equivalent to design load factor of 0.93 (reciprocal). In accordance with Japan's guideline for water facility design (JWWA), design load is commonly applied for design of water facilities. Based on the results of discussion between the Team and PPUC, maximum daily coefficient will, however, be applied in calculation, avoiding confusion in terminology.
4) In the Project, maximum daily water supply in the target year of 2020 will be reduced rather than current year as 2014 because of the reduction of NRW. Therefore, water supply facilities are designed based on current maximum daily water supply at 4MG/day (15,140m^3/day)

Source: JICA Survey Team

Japan's guideline for water facility design (JWWA, 2012) is applied for the Project because there is no designated guideline in Palau for design criteria of water supply facilities. In case that the reference figures will, however, be utilized in practice in Palau, they will be respected if appropriate.

(1) Target Year

It is considered that construction will be completed in 2017 if it is implemented by the Japan's Grant Aid scheme. The target year is, therefore, proposed as 2020, which is three (3) years later from 2017.

(2) Planned Population

According to the Bureau of Budget and Planning, Ministry of Finance, the populations of Koror and Airai States are 11,665 and 2,537 respectively in a statistical yearbook of 2013. This estimation of the population substantiates the depopulation from 2000 to 2005, but not population increase which announced in the past. In the Project, the demand plan is formulated according to the population, described on the Statistical Yearbook 2013 which shows depopulation.

The main reason of depopulation is the outflow population for education / employment, according to an analysis by the above ministry. The population level of 2012 will be maintained if effective countermeasures against the depopulation is undertaken. It is assumed that this is the high forecast scenario. Meanwhile, the low scenario is assumed to be the same as the proportion increase ratio recorded from 2005 to 2012 (Koror: -1.1%, Airai: -1.0%). The average value of the two scenarios is applied to forecast the population to be used in the Project because both high or low scenarios shows

the extreme situations. These population forecasts are shown in Table 2-2-2 to Table 2-2-4, and Figure 2-2-1.

Table 2-2-2 Population Forecast (High Scenario)

Area	2012	2013	2014	2015	2016	2017	2018	2019	2020
Koror State	11,665	11,665	11,665	11,665	11,665	11,665	11,665	11,665	11,665
Airai State	2,537	2,537	2,537	2,537	2,537	2,537	2,537	2,537	2,537
Total	14,202	14,202	14,202	14,202	14,202	14,202	14,202	14,202	14,202

Source: JICA Survey Team

Table 2-2-3 Population Forecast (Low Scenario)

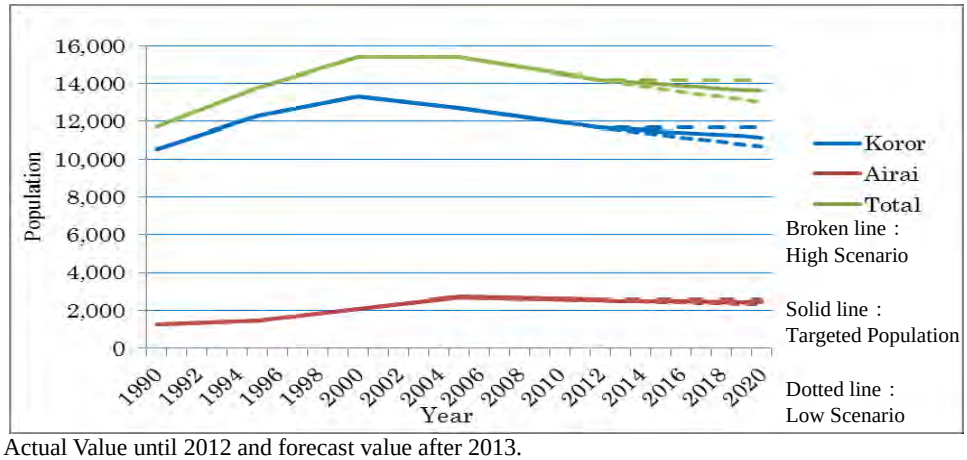
Area	2012	2013	2014	2015	2016	2017	2018	2019	2020
Koror State	11,665	11,537	11,410	11,284	11,160	11,037	10,916	10,796	10,677
Airai State	2,537	2,512	2,487	2,462	2,437	2,413	2,389	2,365	2,341
Total	14,202	14,049	13,897	13,746	13,597	13,450	13,305	13,161	13,018

Source: JICA Survey Team

Table 2-2-4 Population Forecast (Middle Scenario: Targeted Population)

Area	2012	2013	2014	2015	2016	2017	2018	2019	2020
Koror State	11,665	11,601	11,538	11,475	11,413	11,351	11,291	11,231	11,171
Airai State	2,537	2,525	2,512	2,500	2,487	2,475	2,463	2,451	2,439
Total	14,202	14,126	14,050	13,975	13,900	13,826	13,754	13,682	13,610

Source: JICA Survey Team



Notes: Actual Value until 2012 and forecast value after 2013.
Source: JICA Survey Team, based on Statistical Yearbook 2013 and 2005 Census Monograph

Figure 2-2-1 Comparison of Population Forecast

(3) Number of Foreign Visitors

Palau receives more than 100 thousand of foreign visitors per year; on the contrary, its population decreases as less than 20 thousand. An international airport in Palau is located in Airai State. Koror State is a base for business and tourism for foreign visitors, and 93% of rooms for accommodation, such as hotels, are concentrated in Koror State. Therefore, consideration of the number of foreign visitors is indispensable to estimate socio-economic activities as well as water demand for Koror - Airai water supply system.

The increasing number of foreign visitors should be considered in the water demand forecast. According to Palau Visitors Authority (hereinafter referred to as “PVA”), average period of stays of the foreign visitors is approximately 4 days per person. 118,754 persons, which are visitors in 2012 and the highest record of foreign visitors, are converted into approximately 1,301 persons per day. It is

more than 10% of the population of Koror. The number of foreign visitors is forecasted at 169,351 in 2020 as shown in Table 2-2-5.

Table 2-2-5 Forecast of Foreign Visitors for the Project

Category	2008	2009	2010	2011	2012	2013	
Recorded	79,259	71,887	85,593	109,057	118,754	105,061	
Category	2014	2015	2016	2017	2018	2019	2020
High Scenario	113,046	121,637	130,881	140,828	151,531	163,047	175,439
Low Scenario	111,890	119,163	126,909	135,158	143,943	153,299	163,263
Middle Scenario (Planned Scenario)	112,468	120,400	128,895	137,993	147,737	158,173	169,351

Notes: Official data value until 2013 and forecasted value after 2013 by JICA Survey Team
The Project is planned based on the water consumption in 2013 although the number of foreign visitors exceeds 140,000 in 2014. Moreover, the water demand for the foreign visitor is not directly calculated by the number of the foreign visitors, but development of GDP.
Source: PVA (until 2013)

(4) Design Unit Demand / Consumption

In 2009, ADB studied water demand as shown in Table 2-2-6. It is, however, not recommendable to apply the mentioned figures directly for the Project due to the following reasons:

- ADB study was conducted in assumption that the population is increasing. Nevertheless, it is reported in 2013 that the population is decreasing. The reported population for 2012 is 14,202 in the Statistical Yearbook 2013. The number of foreign visitors in 2012 (118,754) is converted to 1,301 persons of Koror per day. The equivalent population is, accordingly, calculated as 15,503. It is smaller than the estimated population by ADB.
- Although the population is decreasing, the number of foreign visitors is increasing. Accordingly the domestic water consumption will be decreased. Nevertheless, the foreign visitors' water consumption, including commercial consumption related to foreign visitors, will be increased. Since the unit water consumption is different between the two categories, it is not appropriate to fix the unit water demand at 180 G/capita/day for equivalent population.

Table 2-2-6 Demand Forecast by ADB (Presented in 2009)

Item	2009	2013	2020
Equivalent Population	17,000	18,000	19,500
Unit Demand	225 G/capita/day (852 L/capita/day)	180 G/capita/day (681 L/capita/day)	180 G/capita/day (681 L/capita/day)
Yearly Demand (Production)	1,396 MG/year (5.3 Mm^3/year)	1,183 MG/year (4.5 Mm^3/year)	1,281 MG/year (4.8 Mm^3/year)
Average Daily Demand (Production)	3.82 MG/day (14,458 m^3/day)	3.24 MG/day (12,263 m^3/day)	3.51 MG/day (13,285 m^3/day)

Source: Final report, "Preparing the Babeldaob Water Supply Project"2009, ADB

In this circumstances, the design water supply is planned as follows:

1) Domestic Consumption

It is considered that there are much wastage of water, including leakage and overuse in the domestic households. The improvement of these conditions is, therefore, an issue for PPUC. It is, however, difficult for PPUC to control these conditions using PPUC's facilities and equipment. Therefore, the Project applies the current consumption level.

Domestic Consumption: Keeping the current level of consumption "68G/capita/day (257L/capita/day)".

2) Commercial / Governmental Consumption

GDP trend of Palau is shown in Table 2-2-7.

The main economic activities in Palau are accommodation, food service, and transportation for foreign visitors. The industries related to foreign visitors are highly contributing to the total GDP of Palau, and they are pulling total GDP increases.

According to the following reasons, it is recommended to apply 3.4% as an increase rate of commercial water consumption:

- GDP for activities related to foreign visitors is highly developing and increasing by 13% annually. The number of foreign visitors is also increasing at a rate of 6 to 7%. Such increase rates may influence the water demand.
- Nevertheless, water production is in flat or decreasing trend. The water production has not increased directly along with the number of foreign visitors. It is not appropriate to apply the increase ratio of foreign visitors directly to the water demand forecast.
- Contribution of the foreign visitors is widely spread to all activities. The Project applies the 3.4% of total GDP increase ratio for the increasing ratio of commercial water consumption.
- GDP of public administration has not increased, and shown a flat trend for the recent 5 years. It is, therefore, recommended to keep the current level of consumption at 0.09G/day for demand forecast.

Commercial consumption: Increasing by 3.4% /year from current consumption at 0.86 MG/day (3,255m^3/day)

Governmental/Administrative consumption: Keeping the current level of consumption at 0.09G/day (341m^3/day)

Table 2-2-7 Increase Rate of GDP

Category	GDP (million USD)					Annual increase Rate (2009-2013)
	2009	2010	2011	2012	2013	
Total GDP at basics prices	156.2	160.9	168.9	178.0	177.3	3.4%
Accommodation and food service activities	22.4	25.6	29.4	35.3	35.1	14.2%
Transportation and storage	7.7	8.5	10.1	11.4	10.6	9.4%
Sub-total of Industry for Foreign Visitors	30.1	34.1	39.5	46.7	45.7	13.0%
Public Administration	28.5	28.4	27.6	27.5	27.9	-0.5%
Wholesale and retail trade; repair of motor vehicles and motorcycles	21.8	23.1	24.4	26.0	28.5	7.7%
Real estate activities	16.7	16.1	16.5	16.0	16.3	-0.6%
Financial Intermediation	7.7	7.7	8.3	9.5	9.5	5.8%
Education	8.9	8.9	8.7	8.4	8.0	-2.5%
Others	42.5	42.6	43.9	43.9	41.4	-0.7%

Source: 2013 Statistical Yearbook, Bureau of Budget & Planning, Ministry of Finance

3) Non-Revenue Water (NRW)

Improvement of energy efficiency through NRW reduction is one of the aims of the Project. NRW reduction should be taken into account to the demand forecast as much as possible.

Current water production is approximately 3.69MG/day (13,967m^3/d) on average. According to the daily reports of KAWTP, maximum daily water production (maximum figure in a year) is around 4.0MG/day (15,140m^3/d). Those figures are equivalent to 2,562G/min (9,697L/min) or 2,778G/min (10,514L/min). Since two or three pumps (1,050G/min capacity) are usually operated for water transmission from KAWTP, the production volumes are mostly matched with the volumes estimated

with the pumping capacity. It is, therefore, assumed that the indicated volumes by flow meter of KAWTP show the actual water production.

It is difficult to grasp water consumption (water volume to be billed) and NRW accurately, due to no deployment of district flow meters and no calibration system for customer meters. Furthermore, meters are not installed for 13% of the customers. The following is, therefore, assumed for the Project as the current situation:

a) Illegal Connection

Illegal connection is not a serious issue in Palau and rarely observed. It is not necessary to count it separately. Water flow for the illegal connections is included in "NRW difficult to eliminate", which is described in the next section.

b) NRW Difficult to Eliminate

It is difficult to eliminate NRW perfectly. This kind of NRW includes the following:

- Illegal connections which are difficult to be detected
- Water leakages which are difficult to be detected or to be repaired quickly
- Emergency uses

No data is available for such water losses. The losses, except emergency uses, should be essentially low if countermeasures are appropriately undertaken such as the scheduled replacement of pipelines, periodical detection or patrol for water leakage and illegal connection, etc. This kind of NRW is, therefore, assumed as 5% of the total NRW ratio.

c) Meter Malfunction and Misreading

In general, meter accuracy decreases with age. It is difficult to replace all old meters immediately although PPUC undertakes the meter replacement project in 2014. Since the number of the replaced meters will be limited, inaccurate meters will remain after the meter replacement project.

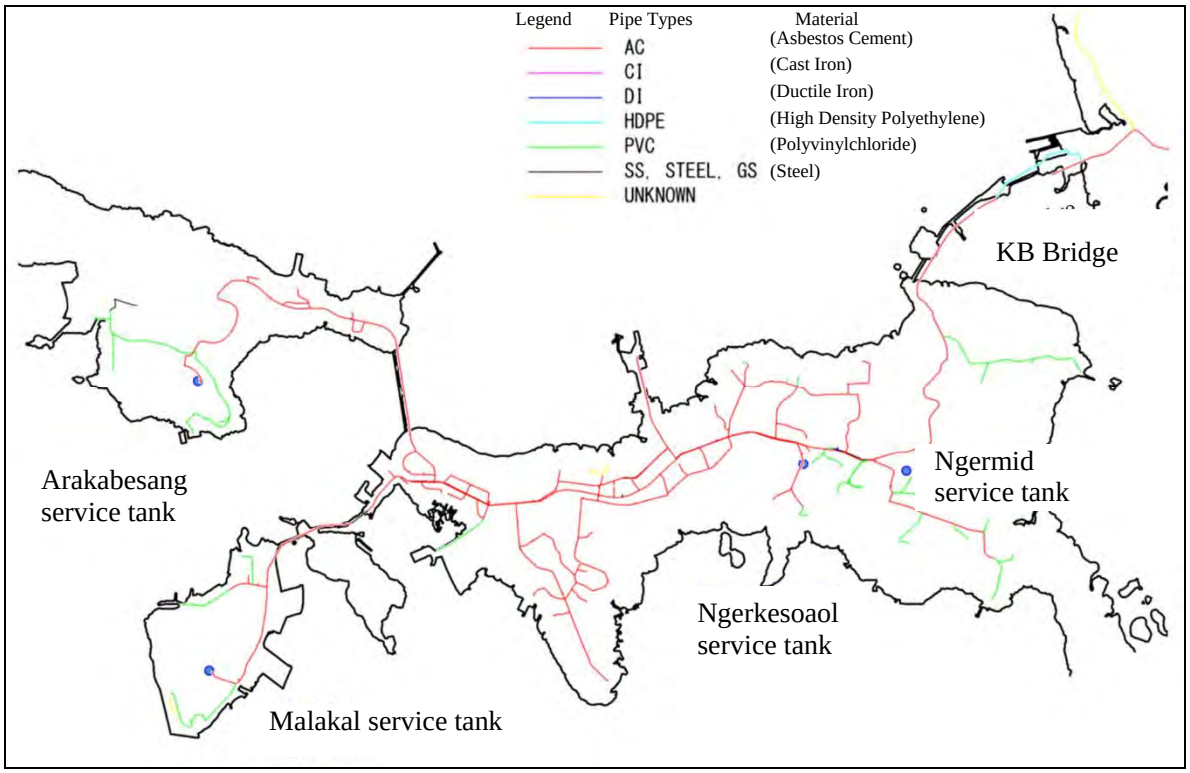
There are not sufficient data to analyze those commercial losses. It is assumed to be lower in NRW because of the following reasons:

- If recorded consumptions were small in water volume, a large volume of commercial losses could be assumed.
- The recorded water consumptions in Koror-Airai is relatively large. If there are more volumes of commercial losses, the actual water consumption could be very large.

According to JICA Technical Cooperation Project: the Project for Improvement of Non-Revenue Water Reduction Capacity for Solomon Islands Water Authority (from 2012 to 2015), NRW caused by meter inaccuracy was estimated 0 to 13.2%. This exampled figure is a good reference for the Project since NRW ratio of the Solomon Islands is also as high as 50%. Taking this example into account, the Project plans to apply 5% of NRW for NRW caused by inaccurate meters.

4) Current Water Leakage from Pipelines

Aged AC pipelines, which were laid 40 years ago or more, accounts for 67% in the water distribution networks. The distribution of AC pipes are shown in Figure 2-2-2.



Source: PPUC

Figure 2-2-2 Distribution of Aged AC Pipes

Moreover, 61% out of the 67% of the AC pipes are relatively large diameter pipelines (6in diameter or more). This aged AC pipe network, including lateral pipe connections from the pipelines, is believed to be a cause of the large amount of water leakage. Since there are no data for water leakage volume and generation frequency, JICA Survey Team attempted to analyze "water leakage impacts" of the existing pipelines by pipelines diameter, length, and material (material includes the factor for age since AC pipes are older than 40 years and others were installed later than them.). The result is shown in Table 2-2-8. According to this table, larger diameter AC pipes (6in diameter or more) may cause 81% of the water leakage. For the above analysis, the following assumptions are taken into consideration:

- Water leakage probability can be calculated by diameter x length.
- AC pipes have more generation frequency than others for water leakage. Accordingly, the water leakage probabilities (impacts) are adjusted by adjustment factors (1.5 for AC and 1.1 for others).
- Table 2-2-9 shows the probabilities of pipe accident analyzed by JWWA. According to this table, the accident probability of AC pipe is 1.33 times higher than that of polyvinyl chloride (hereinafter referred to as "PVC") pipe. When defining the adjustment factor at 1.1 for PVC pipe, the factor for AC pipe should be calculated at 1.5 (=1.1 x 1.33). No data is available for high density polyethylene (hereinafter referred to as "HDPE") pipe. Accordingly, it is recommended to apply the adjustment factor of PVC pipe to that of HDPE pipe. As for steel pipe, details of material and pipe connection are unknown. Consequently, it is recommended to apply the average value (=1.1) between cast iron and steel.

Table 2-2-8 Impacts to Water Leakage of Existing Pipe

Category	Pipe Diameter	AC	HDPE	PVC	Steel	Unknown	Total
Length (m)	6 inches or more	32,449	786	5,784	208		39,227
	Less than 6 inches	3,380	0	7,725	580	2,623	14,308
	Total	35,829	786	13,509	788	2,623	53,535
Share of pipe (%)	6 inches or more	61%	1%	11%	0%	0%	73%
	Less than 6inches	6%	0%	14%	1%	5%	27%
	Total	67%	1%	25%	1%	5%	100%
Section Area of Pipe (in^2)	6 inches or more (assume 8inches)	50	50	50	50	50	
	Less than 6 inches (assume 4inches)	13	13	13	13	13	
Estimated impact for NRW by diameter & length (m x in^2)	6 inches or more	1,630,238	39,489	290,588	10,450	0	1,970,765
	Less than 6inches	42,453	0	97,026	7,285	32,945	179,709
	Total	1,672,691	39,489	387,614	17,735	32,945	2,150,474
Adjustment factor by pipe material (%)	6 inches or more	1.5	1.1	1.1	1.1	1.1	
	Less than 6inches	1.5	1.1	1.1	1.1	1.1	
Adjusted impact for NRW by diameter and length (m x in^2)	6 inches or more	2,445,357	43,438	319,647	11,495	0	2,819,937
	Less than 6inches	63,680	0	106,729	8,014	36,240	214,663
	Total	2,509,037	43,438	426,376	19,509	36,240	3,034,600
Estimated impact for NRW by diameter & length (%)	6 inches or more	81%	1%	11%	0%	0%	93%
	Less than 6inches	2%	0%	4%	0%	1%	7%
	Total	83%	1%	14%	1%	1%	100%

Notes: AC: Asbestos Cement, HDPE: High Density Polyethylene, PVC: Polyvinyl Chloride
Source: JICA Survey Team

Table 2-2-9 Accident Probability by Pipe Materials

Pipe Material	Accident Probability
Ductile Cast Iron	0.02 accident / km /year
Cast Iron	0.20 accident / km /year
Steel	0.02 accident / km /year
PVC	0.30 accident / km /year
AC	0.40 accident / km /year

Source: JWWA (guideline for water facilities rehabilitation 2004)

5) Estimated Breakdown of Current Water Leakage

According to the above mentioned assumptions, the current situation of NRW is simulated as shown in Table 2-2-10.

The water leakage is generated not only on distribution pipelines but also on lateral pipes. The water leakage on lateral pipes would not be a little in volume. The assumed and indicated leakages in the table include such generated water leakage on lateral pipes.

Table 2-2-10 Estimated Breakdown of Current NRW

Category/Items	Statas (Estimated)
Production (MG/day)	3.69
Total NRW (MG/day)	1.78
NRW ratio for total base	48%
a NRW difficult to eliminate (5% of total NRW)	0.09
b Meter malfunction and misreading (5% of Total NRW)	0.09
c Water leakage of pipelines(MG/day)	1.60
Impact of AC (6inches or more)	81%
Impact of other pipes	19%
Water leakage on AC pipes (6 inches or more) (MG/day)	1.3
Water leakage on the pipes (MG/day)	0.3

Notes: Value is estimated by simulation based on the current consumption volume
Source: JICA Survey Team

6) Demand Forecast

a) Assumed NRW Reduction by Pipe Replacement

AC pipes with the larger diameter could be a main cause of the high NRW ratio. The schedule for NRW reduction should be planned along with water leakage reduction in the pipelines.

JICA Survey Team attempted to calculate NRW volume that can be reduced by replacement of the larger diameter AC pipes (6in or more). The calculation was done under the following assumptions:

- The simulation is done under the current consumption conditions. In other words, the simulation would show NRW if replacement was done immediately.
- The replacement is scheduled to be completed in 6 years for total of 32.4km pipes (average 5.5km per year). It is proposed to reduce NRW ratio to 33% or less by 2020 (33% in 2020 is the target of ADB recommendation). It is estimated that NRW ratio will become 32% when 68% of larger diameter pipes are replaced (in 4 years).
- Water production can be decreased by reducing the water leakage on pipelines. According to the decrease of production, it was assumed that volume of “NRW difficult to eliminate” and “Meter malfunction” will be also reduced even if the generation ratios are unchanged.
- The estimation shows that NRW ratio will be reduced to 20% if all the larger diameter pipes are replaced as shown in Table 2-2-11.

Table 2-2-11 Assumed NRW Reduction by Pipe Replacement (Current Consumption)

Rate to Replace Larger AC Pipes (6 in or more) Total 32.5km / Water Production / NRW	Current	2017	2018	2019	2020	2021	2022
		1st year	2nd year	3rd year	4th year	5th year	6th year
		5.5km	11.1km	16.6km	22.1km	27.6km	32.5km
Production (MG/d)	3.69	3.47	3.25	3.03	2.81	2.59	2.39
Total NRW (MG/d)	1.78	1.56	1.34	1.12	0.90	0.68	0.48
NRW Ratio for total base	48%	45%	41%	37%	32%	26%	20%
a NRW difficult to eliminate (5% of total NRW)	0.09	0.08	0.07	0.06	0.05	0.03	0.02
b Meter malfunction and misreading (5% of total NRW)	0.09	0.08	0.07	0.06	0.05	0.03	0.02
c Water leakage on pipelines (MG/d)	1.60	1.38	1.16	0.94	0.72	0.50	0.30
Impact of AC pipes (6 in or more)	81%	78%	74%	68%	58%	40%	0%
Impact of other pipes	19%	22%	26%	32%	42%	60%	100%
Water leakage on AC pipe (6 in or more) (MG/d)	1.30	1.08	0.86	0.64	0.42	0.20	0.00
Water leakage on other pipes (MG/d)	0.30	0.30	0.30	0.30	0.30	0.30	0.30

Source: JICA Survey Team

b) Water Demand Plan and Assumed Schedule for NRW Reduction until 2020

Pipe replacement is able to be commenced by the end of 2015 or by the beginning of 2016. Therefore, the replacement effects on NRW ratio may start to appear in (not to appear before) 2017. To obtain 33% or less NRW ratio in 2020 and the effects of pipe replacement from 2017, JICA Survey Team simulated the water production, consumption and NRW as shown in Table 2-2-12.

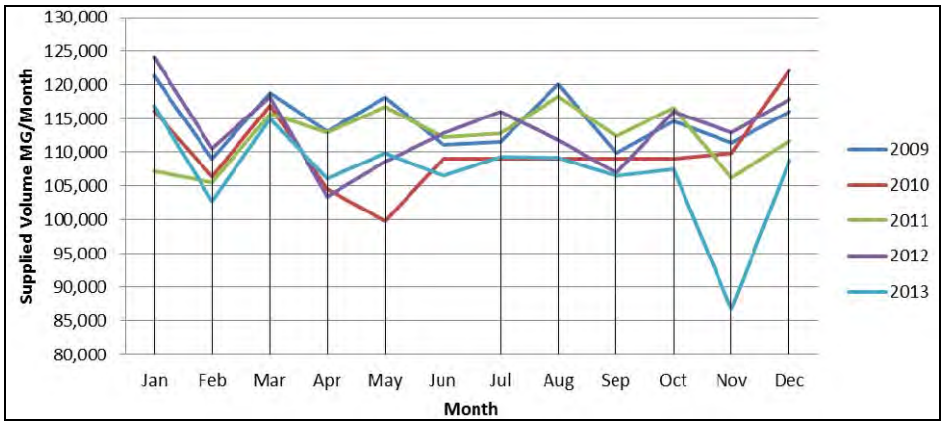
Table 2-2-12 Water Demand Plan until 2020

Category	2013	2014	2015	2016	2017	2018	2019	2020
Population	14,126	14,050	13,975	13,900	13,826	13,754	13,682	13,610
Foreign visitors per day	1,151	1,233	1,319	1,413	1,512	1,619	1,733	1,856
Equivalent population	15,277	15,283	15,294	15,313	15,338	15,373	15,415	15,466
Domestic consumption								
Unit consumption (G/capita/d)	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00
Domestic consumption (MG/d)	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93
Non-domestic consumption (Gov)								
Consumption (MG/d)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Annual increase ratio		0%	0%	0%	0%	0%	0%	0%
Non-domestic consumption (com.)								
Flat rate consumption (MG/d)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Annual increase ratio		3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%
Metered consumption (MG/d)	0.85	0.88	0.91	0.94	0.97	1	1.03	1.07
Annual increase ratio		3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%
Total commercial consumption (MG/d)	0.86	0.89	0.92	0.95	0.98	1.01	1.04	1.08
Grand Total for Consumption (MG/d)	1.91	1.94	1.96	1.99	2.01	2.04	2.06	2.10
NRW								
NRW (MG/d)	1.78	1.79	1.81	1.70	1.64	1.42	1.21	0.99
Production (%)	48%	48%	48%	46%	45%	41%	37%	32%
Average daily water supply (MG/d)	3.69	3.73	3.77	3.69	3.65	3.46	3.27	3.09
Maximum daily water supply (MG/d)	3.95	3.99	4.03	3.95	3.91	3.70	3.50	3.31
Reference								
Production (G/capita/d)	261	265	270	265	264	252	239	227
Production (G/equivalent population/d)	242	244	247	241	238	225	212	200

Source: JICA Survey Team

c) Maximum Daily Production

As mentioned in the previous section, the average daily demand will be reduced to 3.09 MG/day in 2020. Nevertheless, it is not a practical design capacity for the facilities since the water demand fluctuates throughout the year. Figure 2-2-3 shows the fluctuation for the recent 5 years. In general, the peak demand is recorded in December and / or January, which have relatively more foreign visitors and less precipitation.



Notes: In November 2013, very low production was recorded due to water leakage accident at KB Channel.
Source: KAWTP, PPUC

Figure 2-2-3 Current Fluctuation of Water Production

Table 2-2-13 shows the average and maximum daily productions in the recent 5 years. According to the data, the production (demand) of the peak day is approximately 1.07 times of the average. It is, therefore, necessary to design water treatment and transmission facilities (including service tanks) with 1.07 times of average demand. In short, designed maximum daily water supply should be 3.31 MG/day.

The facilities for the Project, however, should be designed according to the present maximum daily water supply, which is 4MG/day (15,140m^3/day), by the following reasons:

- The maximum daily water supply will be decreased as a result of pipe replacements and scheduled leak detection.
- The maximum daily water supply will be decreased along with the progress of pipe replacement.
- In the beginning phase of pipeline improvement, the capacity satisfying the present maximum daily water supply (4MG/day: 15,140m^3/day) is necessary for the water transmission and distribution systems since the pipe replacement is not completed and in progress for improvement.

Table 2-2-13 Load Factor for the Recent 5 Years

	2009	2010	2011	2012	2013	Ave.
Average (MG/d)	3.77	3.62	3.69	3.71	3.58	3.67
Maximum (MG/d)	4.02	3.88	3.86	3.94	4.03	3.94
Maximum daily coefficient	1.07	1.07	1.05	1.06	1.10	1.07
Load Factor (Average / Maximum)	94%	93%	96%	94%	89%	93%

Notes：Data on November 2013 is excluded from the analysis.
Source: KAWTP, PPUC

7) Design Water Supply by Each Service Tank

According to the current water distribution volume, the design water supply by each service tank is simulated, corresponding to planned water distribution zones. Table 2-2-14 shows the simulation results.

Table 2-2-14 Design Maximum Daily Water Supply for Water Distribution Zones

Current Water Distribution Volume According to June-July 2013								
Category		Direct Zone	Airai	Ngermid	Ngerkesoaol	Arakabesang	Malakal	Total
Recorded "Billed water" June-July 2013	G/month	10,714,950	5,588,208	2,635,978	40,058,559	2,840,784		61,838,479
	%	17.3%	9.0%	4.3%	64.8%	4.6%	0.0%	
Converted into Maximum Daily Supply	MG/d	0.69	0.36	0.17	2.6	0.18	0	4
	(m^3/d)	(2,623)	(1,368)	(645)	(9,808)	(696)	(0)	(15,140)
Design Water Distribution for Case after Rearrangement of Zones								
Category		Direct Zone	Airai	Ngermid	Ngerkesoaol	Arakabesang	Malakal	Total
Assumed "Billed water" June-July 2013	G/month		6,985,260	11,953,875	31,801,314	4,734,640	6,363,390	61,838,479
	%	0.0%	11.3%	19.3%	51.4%	7.7%	10.3%	
Converted into Maximum Daily Supply	MG/d	0	0.45	0.77	2.06	0.31	0.41	4
	(m^3/d)	(0)	(1,710)	(2,927)	(7,786)	(1,159)	(1,558)	(15,140)

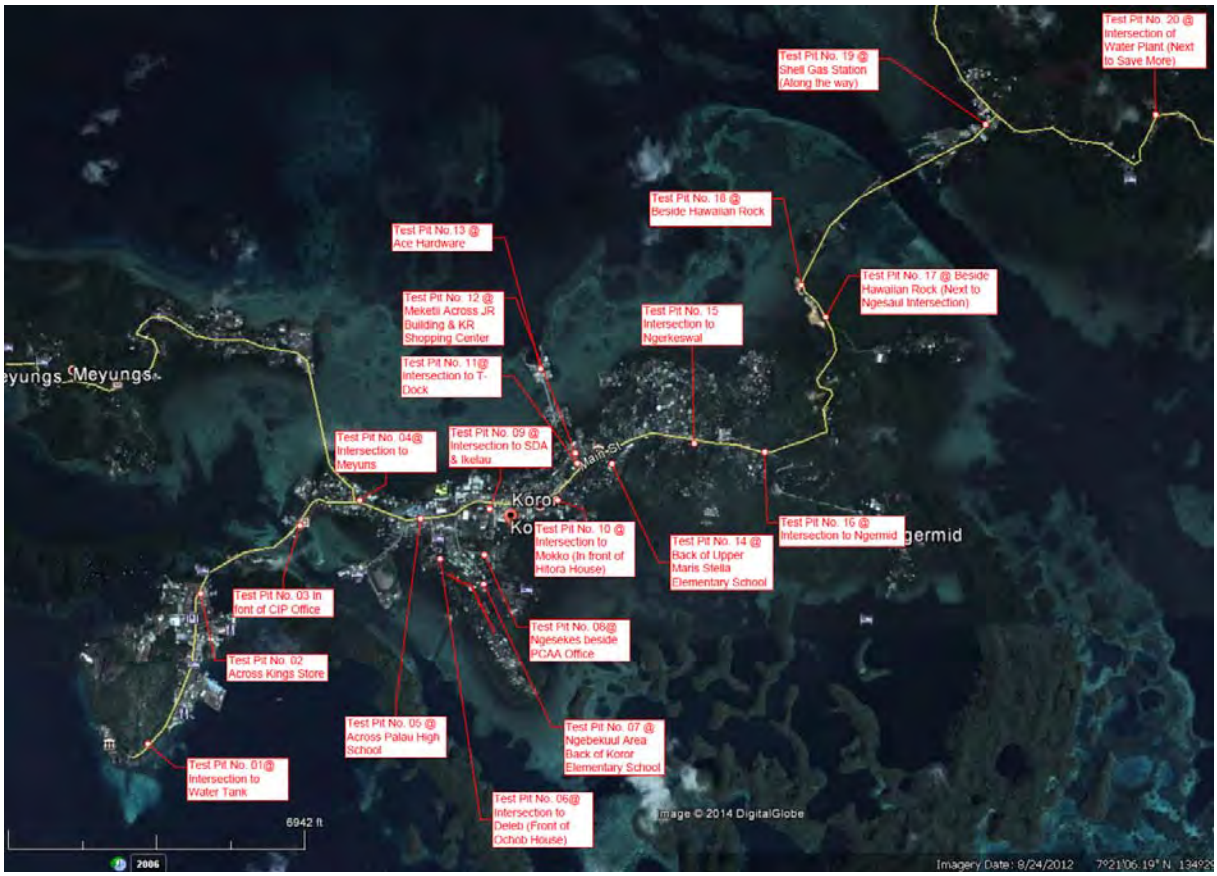
Source: JICA Survey Team

2-2-2-2 Soil Conditions

In order to design the water transmission main and the water distribution pipelines, the test pit survey and soil investigation were conducted. These results are as follows:

(1) Test Pit Survey

Locations of the test pit survey along proposed routes of the water transmission main and the water distribution pipelines are shown in Figure 2-2-4. Twenty (20) points were excavated along the pipeline routes. As a result of the survey, the soils along the pipeline routes are generally in laterite. Nevertheless, along the route from KB Bridge to Ngermid service tank (Survey Point No.16 to No.18), the rock excavation is required for the pipe laying work in this section.

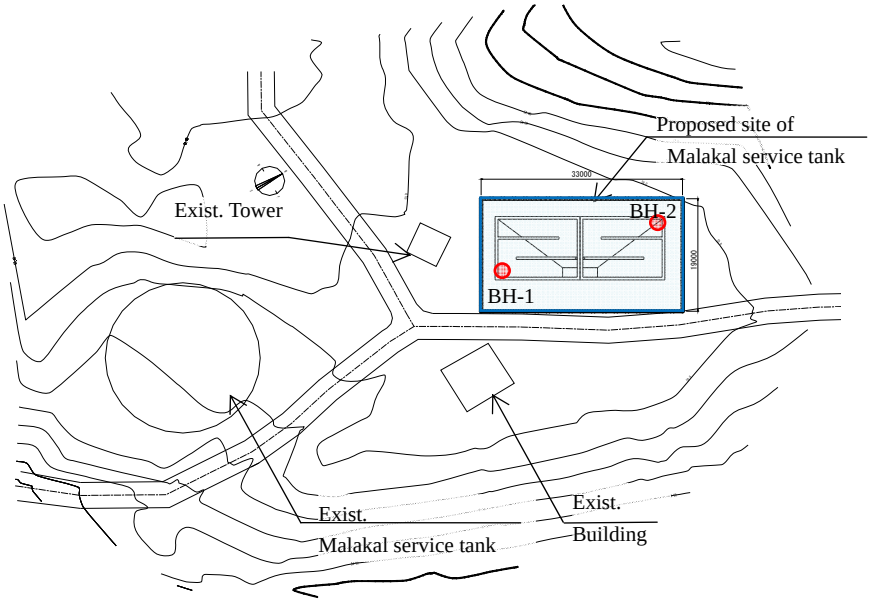


Source: JICA Survey Team

Figure 2-2-4 Test Pit Points

(2) Soil Investigation

Soil investigation and plate loading tests were implemented at BH-1 and BH-2 respectively in the site for the proposed Malakal service tank as shown in Figure 2-2-5. Soil characteristics for the site are configured in accordance with the results of these surveys as shown in Table 2-2-15.



Source: JICA Survey Team

Figure 2-2-5 Location of Soil Investigation

Table 2-2-15 Soil Characteristics

Item	Site for Proposed Malakal Service Tank	
	BH-1	BH-2
Soil	1.0-16.0ft (0.3-4.8m): Clayey Silt >16.0ft (>4.8m): Tuff Siltstone	2.0-7.0ft (0.6-2.1m): Clayey Silt 7.0ft (>2.1m): Tuff Siltstone
N-value	1.0-7.0ft (0.3-2.1m): 8 7.0-12.0ft (2.1-3.6m): 4 12.0-16.0ft (3.6-4.8m): 14 >16.0ft (>4.8m): >50	2.0-7.0ft (0.6-2.1m): 29 7.0ft (>2.1m): >50
Ave. unit volume weight	118 pcf (19 kN/m^3)	128 pcf (20.6 kN/m^3)
Soil bearing capacity (GL-1m)	12.0 psi (82.7 kN/m^2)	11.83 psi (81.5 kN/m^2)

Source: JICA Survey Team

Based on the results of plate loading tests with the depth of 1m from the ground level, allowable soil bearing capacity is configured as 11.83psi (81.5kN/m^2). Accordingly, sufficient soil bearing capacity is expected to be secured because the allowable soil bearing capacity exceeds the dead load of proposed Malakal service tank and the water in the tank at high water level.

Table 2-2-16 Soil Bearing Capacity of Service Tank

Dead load of tank	Load of water	Total load	Allowable soil bearing capacity
46.4 kN/m^2	33.7 kN/m^2	80.1 kN/m^2	81.5 kN/m^2

Source: JICA Survey Team

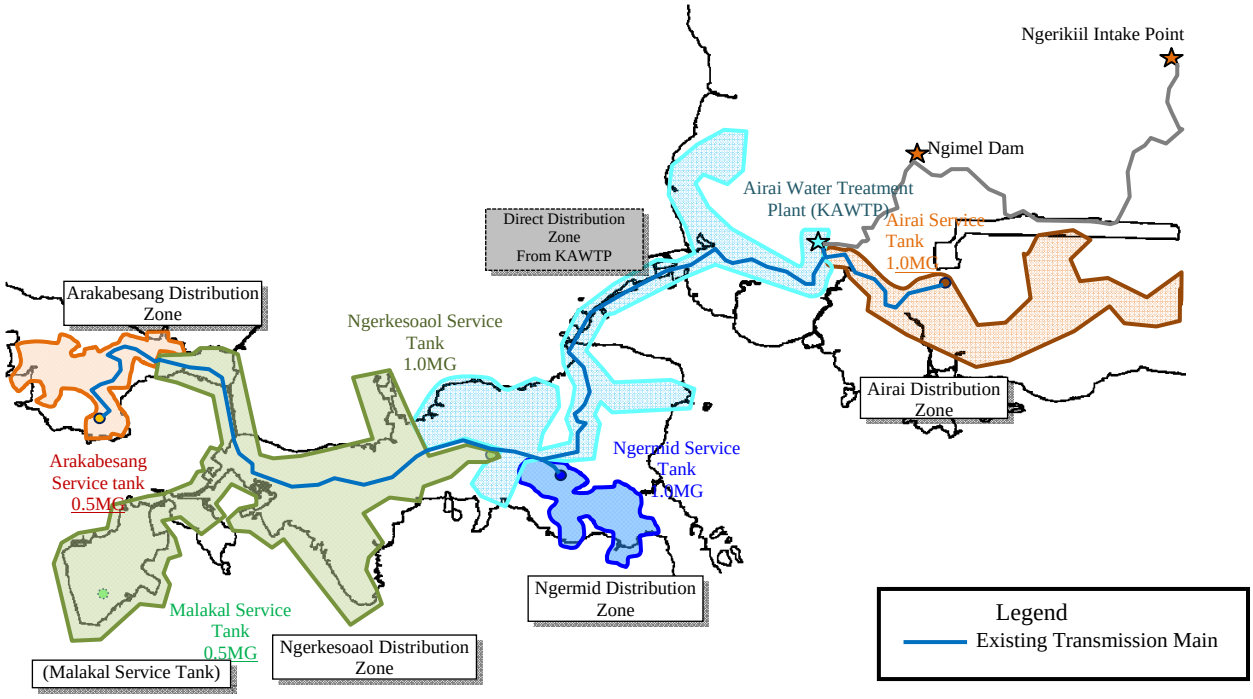
2-2-2-3 Overall Facility Plan

Based on the results of the field surveys, the scope of the Project focuses on “Improvement of water transmission system” and “Improvement of water distribution system (Re-arrangement of water distribution zones and Replacement of water distribution pipelines)“. The conceptual diagram and location map are shown below. The contents of details are described in Section 2-2-4 to Section 2-2-7.

(1) Re-arrangement of Water Distribution Zones

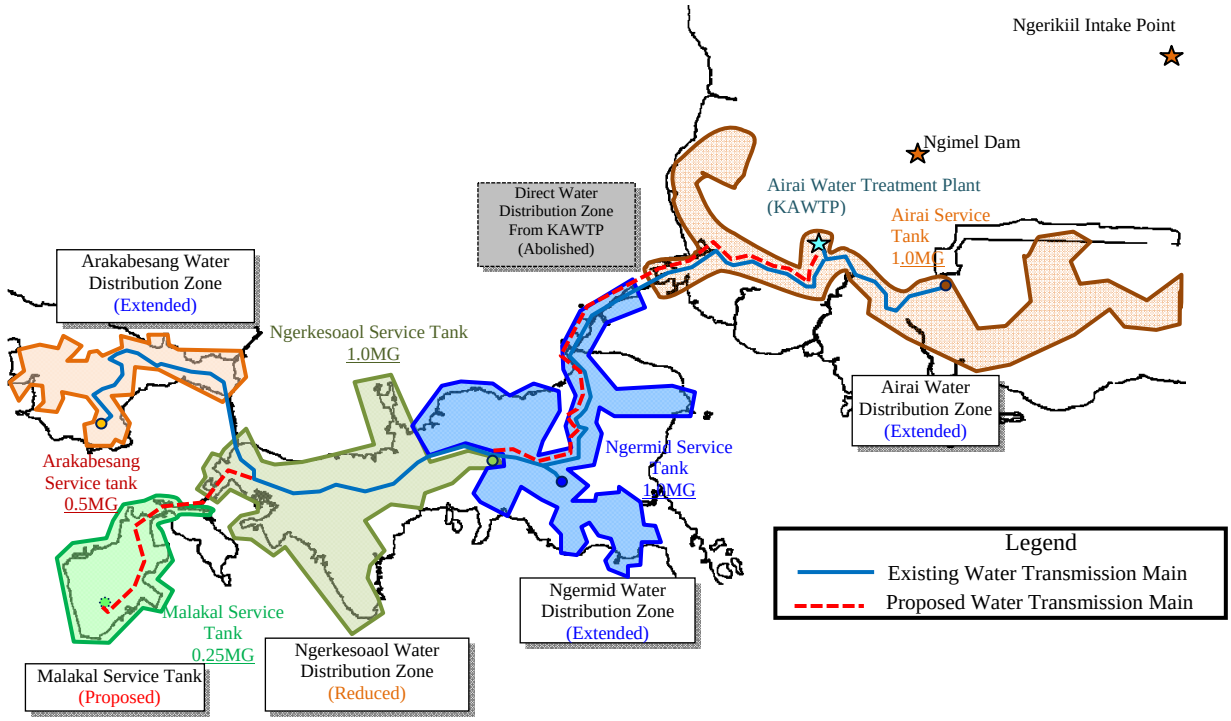
The current water distribution zones are shown in Figure 2-2-6. The current water distribution system is composed of five water distribution zones; Airai water distribution zone, Ngermid water distribution zone, Ngerkesoaol water distribution zone, Arakabesang water distribution zone, and the direct water distribution zone from KAWTP. In the Project, the re-arrangement/abolishment of water distribution zones is proposed as shown in Figure 2-2-7.

Re-arrangement of Ngerkesoaol water distribution zone should be undertaken together with the establishment of Malakal service tank. And the direct water distribution zone should be eliminated.



Source: JICA Survey Team based on information of PPUC

Figure 2-2-6 Current Water Distribution Zones (Service Block)

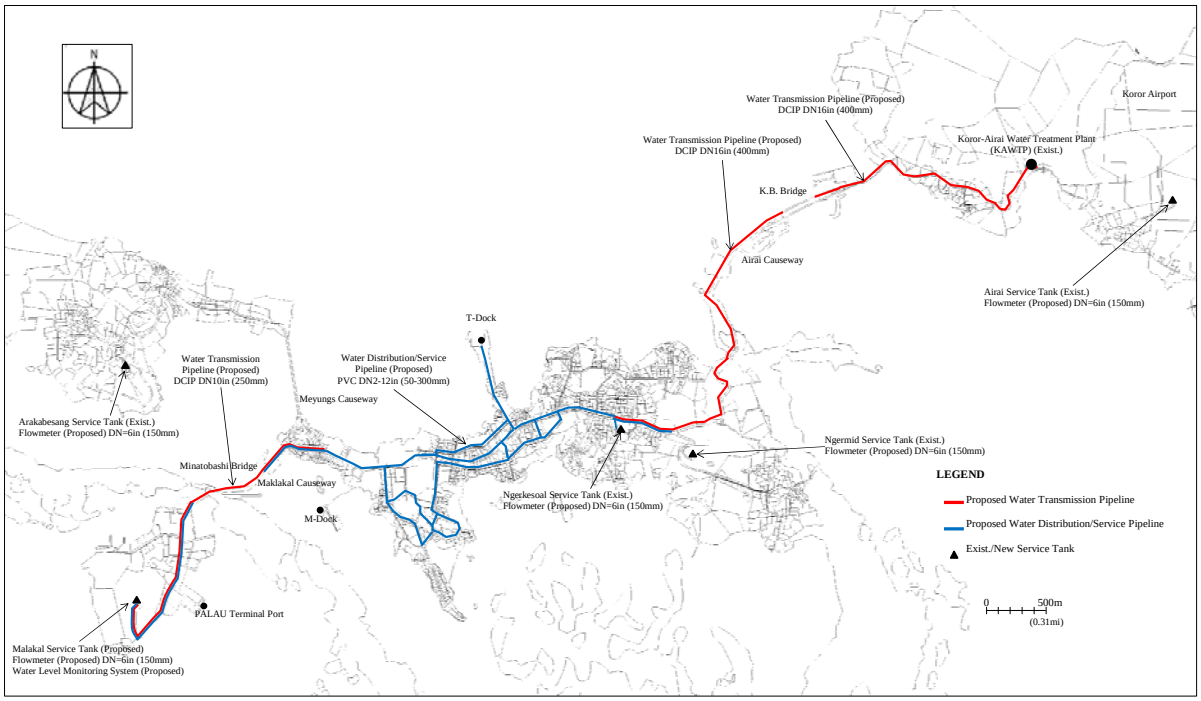


Source: JICA Survey Team based on information of PPUC

Figure 2-2-7 Proposed Water Distribution Zones (Service Block)

(2) Proposed Overall Facility

Figure 2-2-8 shows the proposed layout of all facilities to be constructed in the Project. The Project will implement not only the re-arrangement as described above, but also construction of an additional water transmission main from KAWTP and an exclusive water transmission main to the proposed Malakal service tank.

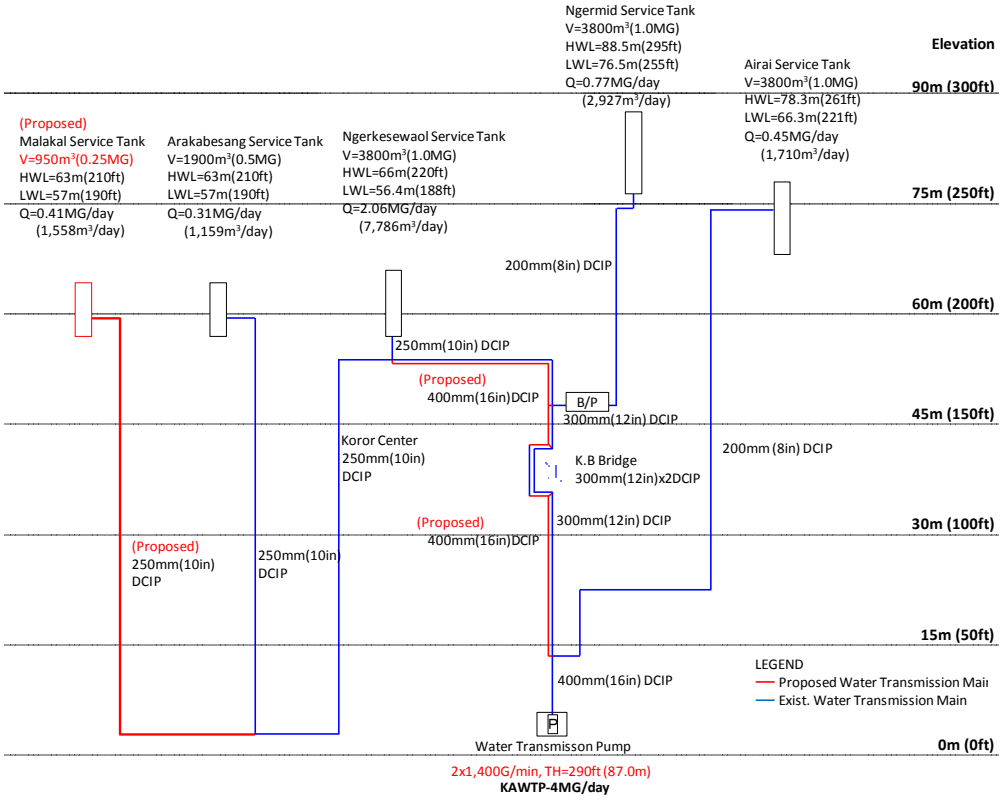


Source: JICA Survey Team

Figure 2-2-8 Proposed Facilities of Improved Koror-Airai Water Transmission and Distribution System

(3) Water Transmission System Diagram

Figure 2-2-9 shows the proposed water transmission system diagram. Water transmission system is by pressure (pumping from KAWTP), and water distribution system is by gravity through each service tank.

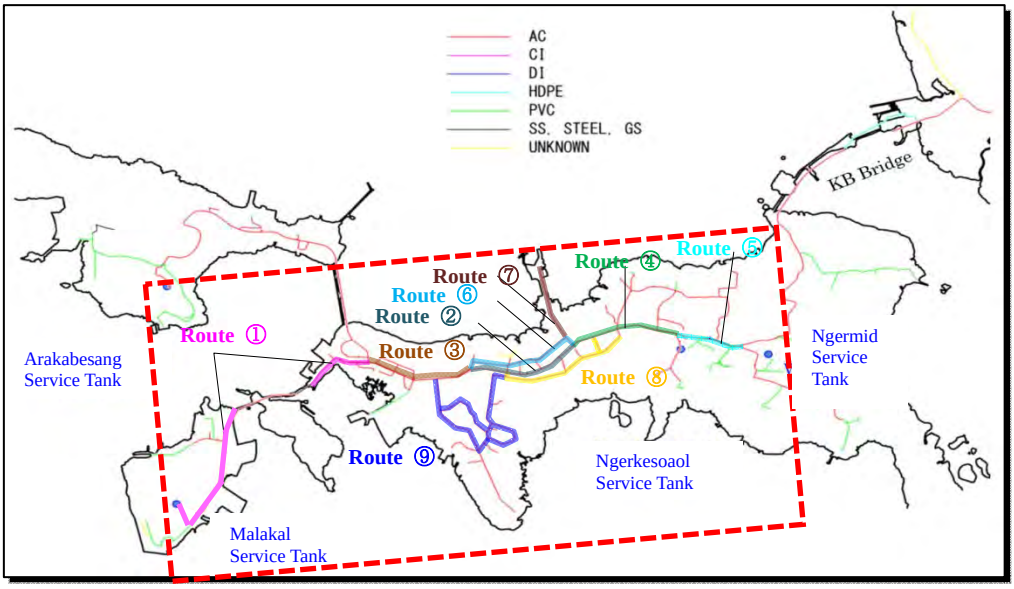


Source: JICA Survey Team

Figure 2-2-9 Proposed Koror-Airai Transmission System Drawing

(4) Scope of Aged Water Pipelines Replacement

In Koror State, the aged AC pipelines, which were laid for 40 years or more, occupies about 60% or more of the water distribution networks. Due to the frequent water leakage, it is required to reduce water leakage as well as to strengthen the distribution pipelines promptly. Nevertheless, the simultaneous replacement of all AC pipes is not easy due to difficulties of scheduling and budgeting. Accordingly, this replacement work should be scheduled and commenced in order of feasibility and priority. The detail for prioritization is described later in Section 2-2-7. Figure 2-2-10 shows the target area of prioritized replacement of aged distribution pipelines.



Source: JICA Survey Team

Figure 2-2-10 Target Area of Prioritized Replacement of Aged Water Pipelines

2-2-2-4 Transmission Main

(1) Design Water Transmission Flow

Table 2-2-17 shows the summary of design water transmission flow to each service tank.

Table 2-2-17 Design Transmission Flow to Each Service Tank

Name	Capacity	Design Transmission Flow
Airai service tank (existing)	1.0MG (3,800m^3)	0.45MG/day (1,710m^3/day)
Ngermid service tank (existing)	1.0MG (3,800m^3)	0.77MG/day (2,927m^3/day)
Ngerkesoaol service tank (existing)	1.0MG (3,800m^3)	2.06MG/day (7,786m^3/day)
Arakabesang service tank (existing)	0.5MG (1,900m^3)	0.31MG/day (1,159m^3/day)
Malakal service tank (proposed)	0.25MG (950m^3)*	0.41MG/day (1,558m^3/day)

Notes: * Refer to Section 2-2-2-6
Source: JICA Survey Team

(2) Proposed Water Transmission Main

Treated water in KAWTP flows into a pump pit. It is transmitted to four (4) existing service tanks in total in Koror and Airai States. There are two (2) water transmission pumps in KAWTP and each pump is specified with capacity of 1,400G/min (5.3m^3/min) for flow and 290ft (87.0m) for total head. Total capacity of daily water transmission flow is equivalent to 4MG/day (15,140m^3/day).

Current water transmission flow has exceeded the capacity for the existing water transmission main. Accordingly, three (3) alternatives were compared to determine the proposed water transmission main in Sector Development Framework. Alternatives were as follows;

- Case-1: To utilize the existing water transmission main, and to replace the existing transmission pump with a high head transmission pump

- Case-2: To to utilize the existing water transmission pipeline, and to add a booster pump for a low pressure area
- Case-3: To add a water transmission pipeline (double pipelines in total)

As shown in Table 2-2-18 and Table 2-2-19, the comparison result indicates that Case-3 (additional water transmission pipeline) is the most environmentally-friendly way, and able to transmit the water with the present level of electricity consumption.

At present, the cost recovery ratio for WWO is only 38% and the financial condition is in deficit. Considering this present cost recovery ratio, Case-3 is also optimal because of the lowest option in O&M cost.

The conceptual diagram is shown in Figure 2-2-11.

Table 2-2-18 Alternatives for Proposed Water Transmission System (1)

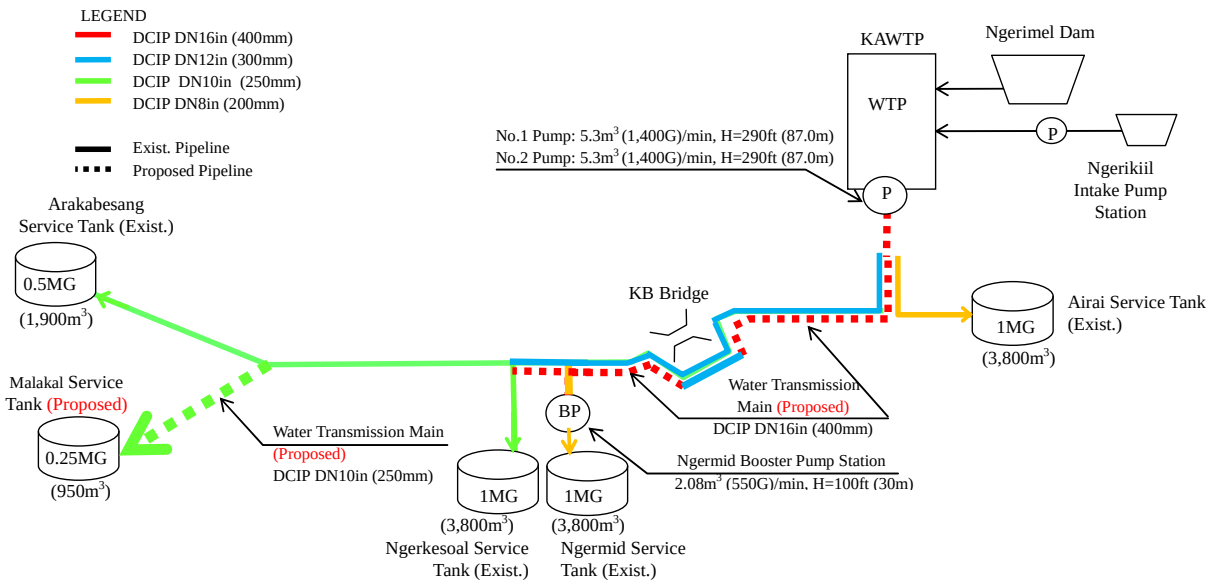
Case		Water Transmission Pump		Booster Pump			Pump Output			
		Flow (Q)	Total Head (H)	Flow (Q)	Total Head (H)	Distance from KAWTP	Transmi-ssion	Booster	Total	Difference from Case-0
		MG/day (m^3/day)	ft (m)	MG/day (m^3/day)	ft (m)	ft (m)	kW -	kW -	kW -	kW (%)
0	Current (Total head is insufficient to deliver the water to the service tanks.)	4.0 (15,140)	290 (87.0)	- -	- -	- -	219 -	- -	219 -	- (1.00)
1	Case-0 +High head transmission pump (Transmission by high head pump)	4.0 (15,140)	567 (170.0)	- -	- -	- -	427 -	- -	427 -	208 (1.95)
2	Case-0 +Booster pump (No change of transmission pipelines, additional booster pump)	4.0 (15,140)	290 (87.0)	3.3 (12,501)	283 (85.0)	4,921 (1,500)	219 -	176 -	395 -	176 (1.80)
3	Case-0 +Additional pipeline (Double pipelines in total) (Diameter of additional pipe: 16in (400mm))	4.0 (15,140)	290 (87.0)	- -	- -	- -	219 -	- -	219 -	0 (1.00)

Source: JICA Survey Team

Table 2-2-19 Alternatives for Proposed Water Transmission System (2)

Case	Advantage	Disadvantage	Ranking
Case-1	1) Not necessary to install an additional water transmission main 2) Minimum initial (construction) cost	1) Approximately double electricity consumption compared to that of the present 2) High possibility of pipe explosion because of the high pressure in the pipes	3rd
Case-2	1) Not necessary to install an additional water transmission main 2) Relatively low initial cost because an additional construction is only for a booster pump	1) Almost double electricity consumption compared to that of the present	2nd
Case-3	1) Not necessary to change pumps 2) Minimum O&M cost because electricity consumption is same as that of the present	1) Necessary the initial cost for additional water transmission pipe 2) Necessary to negotiate on utilization of the road	1st

Source: JICA Survey Team



Source: JICA Survey Team

Figure 2-2-11 Schematic Diagram of Proposed Water Transmission System

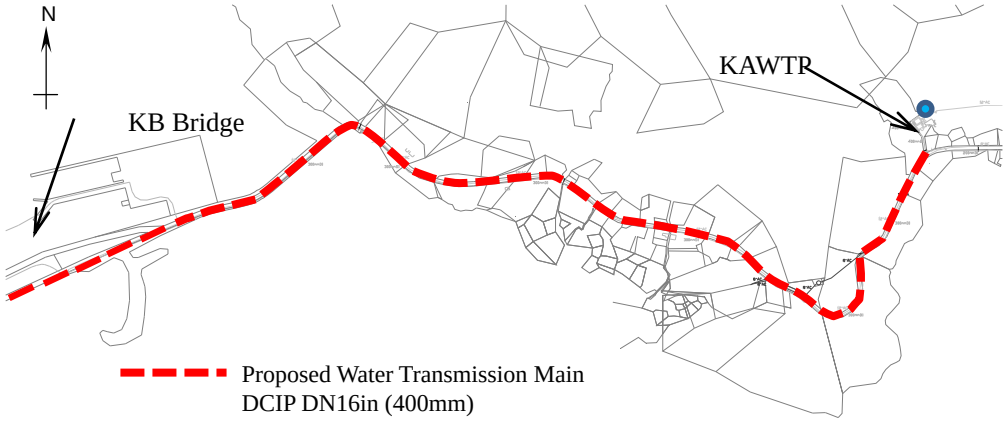
Proposed water transmission main is shown in Figure 2-2-12 to Figure2-2-14. Table 2-2-20 shows a summary of proposed water transmission main. It is necessary to suspend water supply during construction works connecting to the existing water transmission main.

Water transmission mains along KB Bridge is out of scope of the Project since the undersea pipeline along KB Bridge will be replaced by PPUC for a bridge-attached pipeline. In February 2015, JICA Survey Team confirmed the shop drawings for this replacement work. Based on these drawings, the pipe connection method to the bridge-attached pipeline in the Project was designed as Figure 2-2-15. It should be noted that this design should be examined with the as-built drawings of the bridge-attached pipeline at the detailed design stage.

Table 2-2-20 Summary of Proposed Water Transmission Main

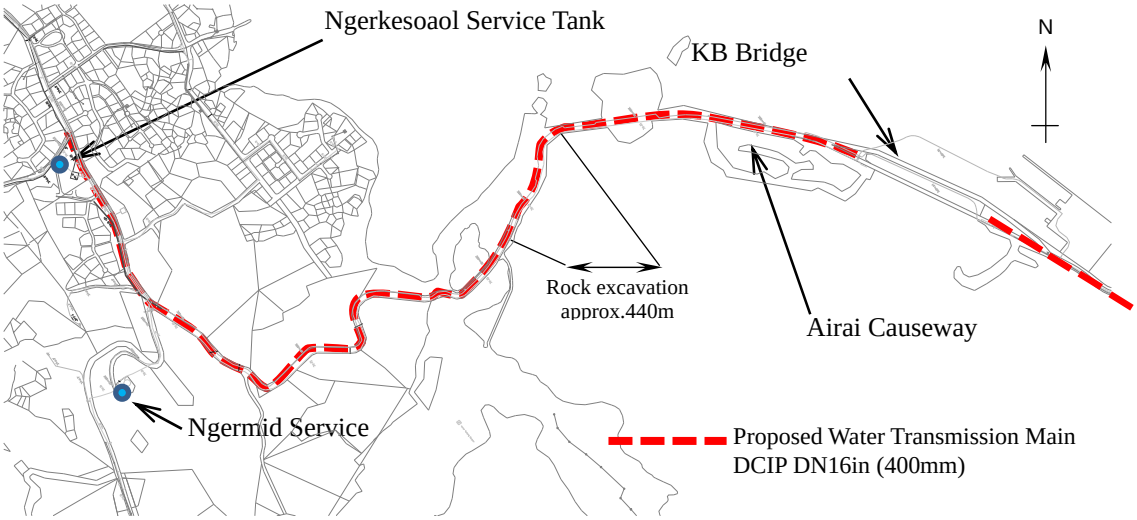
No.	Location	Material/Diameter	Length
1	KAWTP - KB Bridge (Airai side)	DCIP, 16in (400mm)	1.24 mi (1,990m)
2	KB Bridge (Koror side) - Ngerkesoaol service tank branch	DCIP, 16in (400mm)	2.00 mi (3,196m)
3	PVA intersection – Malakal service tank	DCIP, 10in (250mm)	1.93 mi (3,094m)

Source: JICA Survey Team



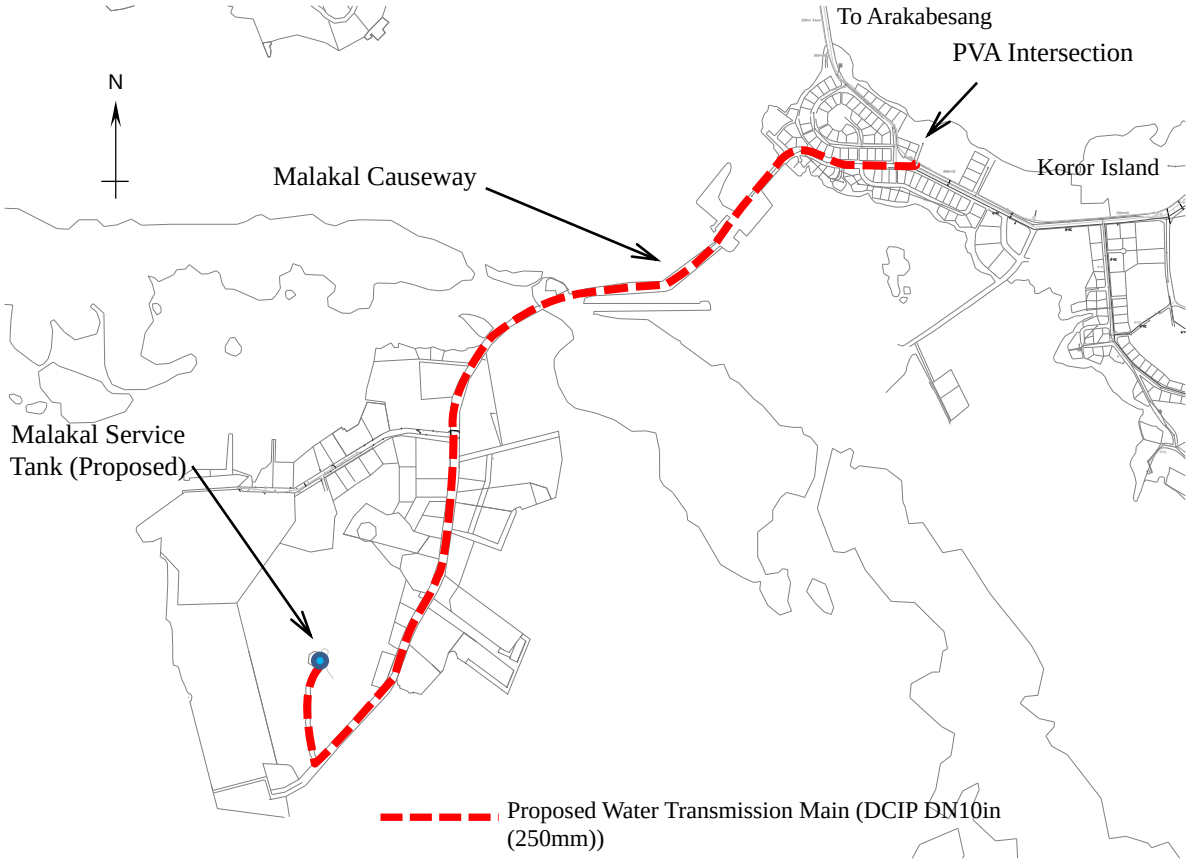
Source: JICA Survey Team

Figure 2-2-12 Proposed Water Transmission Main (KAWTP - KB Bridge at Airai side)



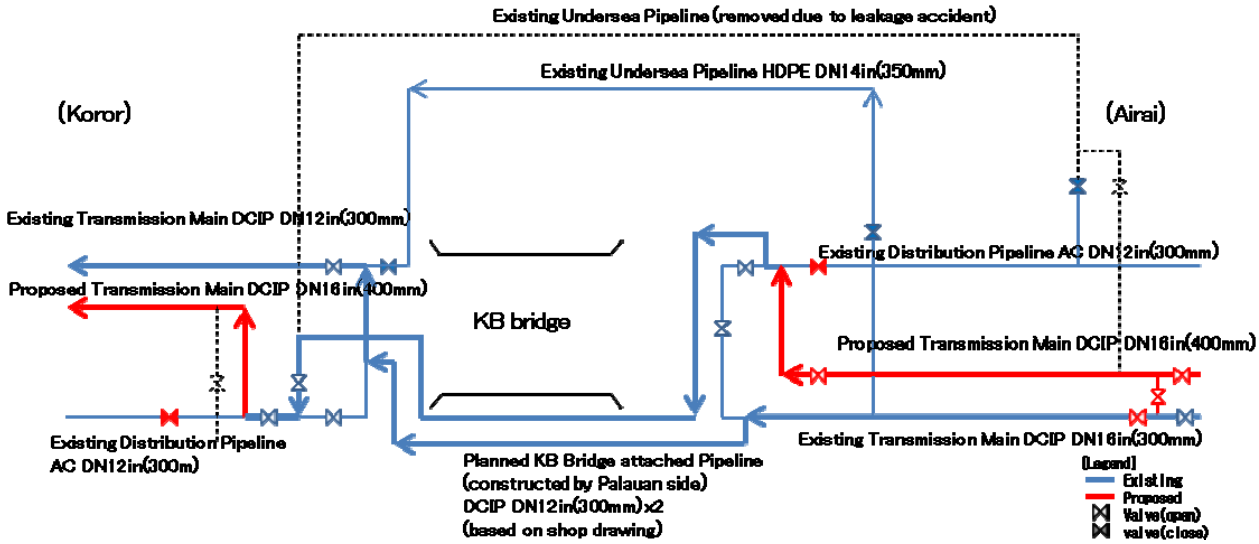
Source: JICA Survey Team

Figure 2-2-13 Proposed Water Transmission Main (KB Bridge at Koror side - Ngerkesoaol service tank branch)



Source: JICA Survey Team

Figure 2-2-14 Proposed Water Transmission Main (PVA intersection - Malakal service tank)



Source: JICA Survey Team

Figure 2-2-15 Proposed Connecting Method to Bridge Attached Pipeline

(3) Pipe Specifications

1) Pipe Material

Ductile Cast Iron Pipe (hereinafter referred to as "DCIP"), Galvanized Steel (hereinafter referred to as "GS") Pipe and Steel Use Stainless (hereinafter referred to as "SUS") Pipe, which are listed in the Japan's guideline for water facility design (published by JWWA), are compared from the technical aspects (such as durability and workability) and the financial aspects (such as construction cost and O&M cost) as shown in Table 2-2-21. Although PVC Pipe and Poly-ethylene (hereinafter referred to as "PE") Pipe are also listed, these are excluded from the table because the design working pressure at 199psi (1.37MPa) (which is calculated as the maximum hydrostatic pressure plus water hammer pressure) exceeds 109psi (0.75MPa) of their allowable working pressure.

Based on the comparison, DCIP is selected for the Project because of the longest durability, the best workability and the lowest cost.

Table 2-2-21 Comparison of Pipe Material

Item	Ductile Cast Iron Pipe (DCIP)	Galvanized Steel (GS) Pipe	Steel Use Stainless (SUS) Pipe
1. Durability			
(1)Maximum working pressure	580-725psi (4.0-5.0MPa) DN3.2-24in	218psi (1.5MPa)	218psi (1.5MPa)
(2)Lifetime	➢ Advantageous in durability. Lifetime is 40 years based on Local Public Enterprise Act in Japan. ➢ Life time of rubber ring is 30 years or more.	➢ Advantageous in durability. Lifetime is 25 years or more depending on O&M. ➢ Necessary to pay attention of painted parts when welding on the site.	➢ Advantageous in durability. Lifetime is 30 years or more depending on O&M.
(2)Resistance to erosion	➢ Exterior: Advantageous in anticorrosion because of tar epoxy coating. ➢ Interior: Advantageous in anticorrosion because of mortar lining.	➢ Exterior: Less reliability for damage and corrosion than DCIP. ➢ Interior: less advantageous in anticorrosion than DCIP	➢ Exterior & Interior: Advantageous in anticorrosion. ➢ Necessary for exterior coating against corrosive soil.

Item	Ductile Cast Iron Pipe (DCIP)	Galvanized Steel (GS) Pipe	Steel Use Stainless (SUS) Pipe
2. Workability			
(1)Workability	➢ Easy and rapid connection works. ➢ Possible for rapid backfill after connection. ➢ Possible for connection works under rainfall.	➢ Necessary for high skill on welding and coating at site and longer construction period than DCIP. ➢ Necessary for dry condition for connection works.	➢ Necessary for high skill on welding and coating at site and longer construction period than DCIP. ➢ Necessary for dry condition for connection works.
(2)Foundation, backfilling	➢ No special foundation necessary in general. ➢ Advantageous in compacting workability because of high strength and ductility of pipes.	➢ Necessary for compacted sand foundation to prevent deflection and damage on pipe.	➢ Necessary for compacted sand foundation to prevent deflection and damage on pipe.
3. Cost of Construction and O&M			
(1)Ratio of pipe cost	1.0	1.7	4.2
(2)Construction works	➢ No Special foundation necessary in general. ➢ Possible for utilization of excavated soil. ➢ Advantageous in backfill cost and surplus soil disposal cost.	➢ Necessary for longer construction period due to interruption of pipe connection works caused by frequent rainfalls.	➢ Necessary for longer construction period due to interruption of pipe connection works caused by frequent rainfalls.

Source: JICA Survey Team

2) Pipe Diameter

Diameter of the proposed water transmission main is configured by hydraulic calculation with Hazen-Williams formula for the whole Koror-Airai water transmission system. Design conditions are assumed as follows.

- Hazen-Williams formula: $H=10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L$

  where,
  H: Friction head loss (m)
  C: Hazen-Williams coefficient
  D: Inner diameter (m)
  Q: Flow (m^3/s)
  L: Length of pipeline (m)

- Hazen-Williams coefficient: C=110
- Design maximum daily water transmission flow: Q=4MG/day (15,140m3/day) at outlet of KAWTP
- Total head of water transmission pump: h=290ft (87.0m)

Table 2-2-22 shows the result of hydraulic calculation for the proposed water transmission main. The diameters of the proposed water transmission main are as follows.

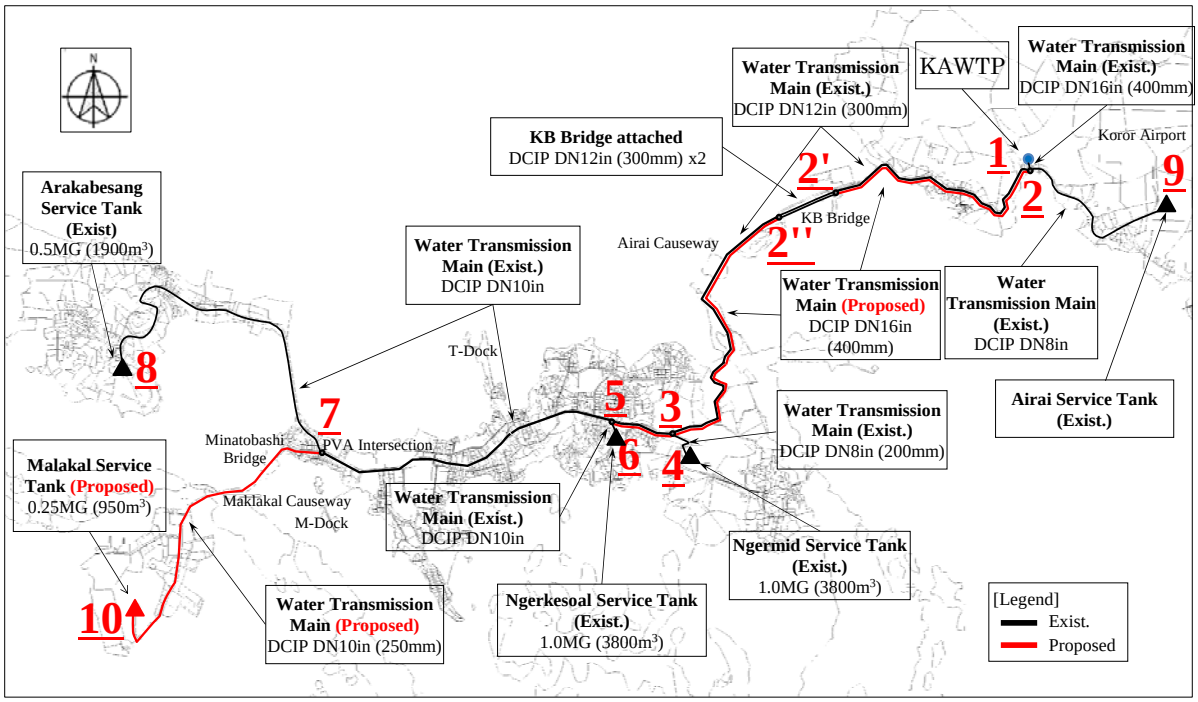
- KAWTP - Ngerkesoaol service tank branch: 16in (400mm)
- PVA intersection – Malakal service tank: 10in (250mm)

Table 2-2-22 Result of Hydraulic Calculation for Proposed Water Transmission Main

Location *1		Design Flow		Nominal Dia.		Length		Effective Head (End) *4		Hydrostatic Pressure (End)	
Start	End	MG/d	m^3/d	inch	mm	ft	m	ft	m	ft	m
1	2	4.00	15,140	16	400	400	120	294	88	297	89
2	2’	3.55	13,430	18.5 *3	463 *3	7,200	2,160	249	75	268	80
2’	2”	3.55	13,430	15.6 *3	390 *3	1,700	510	239	72	268	80
2”	3	3.55	13,430	18.5 *3	463 *3	8,900	2,670	56	17	107	32
2	9	0.45	1,710	8	200	5,900	1,770	24	7	46	14
3	4	0.77	2,927	8	200	1,600	480	47 *2	14 *2	113 *2	34 *2
3	5	2.77	10,503	18.5 *3	463 *3	1,800	540	94	28	148	45
5	6	2.06	7,786	10	250	500	150	24	7	87	26
5	7	0.72	2,717	10	250	9,100	2,730	200	60	276	83
7	8	0.31	1,159	10	250	11,800	3,540	14	4	97	29
7	10	0.41	1,558	10	250	8,600	2,580	13	4	97	29

Notes: *1: 1:KAWTP, 2:Branch of KAWTP, 2’:KB Bridge (Airai side), 2”:KB Bridge (Koror side), 3:Ngermid Branch, 4: Ngermid service tank, 5:Ngerkesewaol Branch, 6: Ngerkesoaol service tank, 7:PVA intersection, 8:Arakabesang service tank, 9:Airai service tank, 10: Malakal service tank
*2: Pressure increase of Ngermid Booster Pump is 100ft (30m) in total head.
*3: Conversion dia. for parallel pipes: 18.5in (463mm) corresponds to “16in+12in (400mm+300mm), and 15.6in (390mm) corresponds to “12in+12in (300mm+300mm). Dia. of additional pipeline between KAWTP and Ngerkesoaol Branch is 16in (400mm). The bridge-attached pipes will be 12in+12in (300mm+300mm) on KB Bridge.
*4: When effective head for the end of pipeline is positive, design volume is able to be transmitted. In case of service tanks, the effective head should be higher than the high water level.

Source: JICA Survey Team



Source: JICA Survey Team

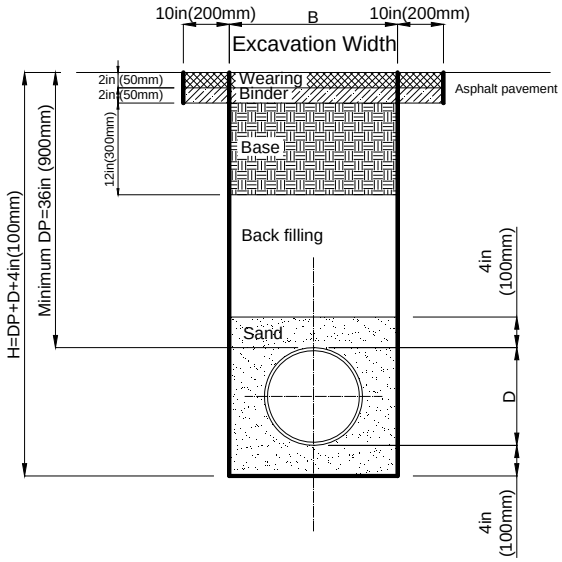
Figure 2-2-16 Location Map for Hydraulic Calculation

3) Typical Pipe Trench

Open cut method is selected to lay the proposed water transmission main. Typical pipe trench is shown in Figure 2-2-17. The minimum earth cover is 36in (90cm) based on the internal rule of PPUC.

The open cut method is advantageous in the following points although BPW recommended a pipe jacking method because the open cut method would damage the road pavement. The pavement work is described in Section 2-2-7 (3).

- The pipe jacking method is advantageous in the construction cost in case of three (3) meters depth or more in general.
- The proposed water transmission main is a pressured pipeline. Accordingly most of the pipelines are able to be laid at the minimum earth cover.
- In case of pipe jacking method, it is difficult to install pipelines in parallel with the existing water transmission main, and pipes shall be installed deeper. Accordingly, its construction cost will be higher.
- Merit in scale for the allowable jacking length is little due to a lot of curves along the proposed route.
- Merit in traffic obstruction by the pipe jacking method is not so large because of the light traffic volume.



Nominal Diameter	Typical Trench Width: B	Typical Trench Depth: H
DN16in(400mm)	34in(850mm)	57in(1429mm)
DN10in(250mm)	28in(700mm)	51in(1274mm)

Source: JICA Survey Team

Figure 2-2-17 Typical Pipe Trench for Proposed Water Transmission Main

4) Pipe Thickness

Pipe thickness is configured with the following formula with consideration of inner and outer pressures.

$$t = \frac{(1.25P_s + P_d) + \sqrt{(1.25P_s + P_d)^2 + 8.4(K_f W_f + K_t W_t)S}}{2S} d$$

Where,

t: Pipe thickness (mm)
H: Minimum earth cover =0.9m
Ps: Hydrostatic pressure (MPa) =0.934MPa
Pd: Water hammer pressure (MPa) =0.44MPa
Kf: Coefficient based on bearing angle of pipe bottom
In case of 2θ=60°, Kf: pipe top=132×10^{-6}, pipe bottom=223×10^{-6}
Kt: Pipe top=76×10^{-6}, Pipe bottom=11×10^{-6}
Wf: Earth pressure by earth cover (kN/m^2) $= \gamma \times h$
Wt: Earth pressure by wheel load (kN/m^2) $= \frac{2\times100\times(1+0.5)}{2.75\times(0.2+2\times h)}$
h: Earth cover (m) =0.9m
γ: Unit weight of soil (kN/m^3) =20kN/m^3
S: Tensile Strength = 420 (N/mm^2)
d: Inner Diameter (mm)

Pipe thickness is calculated at both the pipe top and bottom, and the larger calculated value is selected. The result is shown in Table 2-2-23. Finally, K-9 is adopted for DCIP DN16in (400mm) and DN10in (250mm).

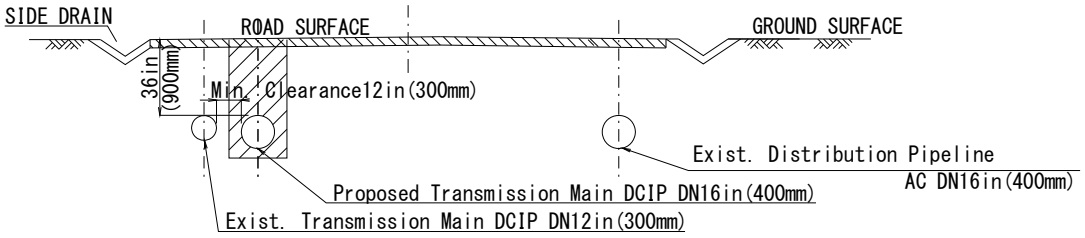
Table 2-2-23 Calculation Result for Pipe Thickness

Earth cover: h (m)		0.90		3.00		0.90		3.00	
Position of pipe		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Ps	MPa	0.934	0.934	0.934	0.934	0.934	0.934	0.934	0.934
Pd	kN/m^2	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
Wt	kN/m^2	5.45E+01	5.45E+01	1.76E+01	1.76E+01	5.45E+01	5.45E+01	1.76E+01	1.76E+01
Wf		1.80E+01	1.80E+01	6.00E+01	6.00E+01	1.80E+01	1.80E+01	6.00E+01	6.00E+01
Kf		1.32E-04	2.23E-04	1.32E-04	2.23E-04	1.32E-04	2.23E-04	1.32E-04	2.23E-04
Kt		7.60E-05	1.10E-05	7.60E-05	1.10E-05	7.60E-05	1.10E-05	7.60E-05	1.10E-05
S	N/mm^2	420	420	420	420	420	420	420	420
d	mm	412.8	412.8	412.8	412.8	260.4	260.4	260.4	260.4
t	mm	3.28	2.92	3.71	4.28	2.07	1.84	2.34	2.70
max(Top, Bottom) mm		3.28		4.28		2.07		2.70	
T=(t+2)+1	mm	6.28		7.28		5.07		5.70	
Diameter		DN16in (400mm)				DN10in (250mm)			
Proposed Pipe		K9				K9			
Proposed Pipe Thickness mm		8.1				6.8			

Source: JICA Survey Team

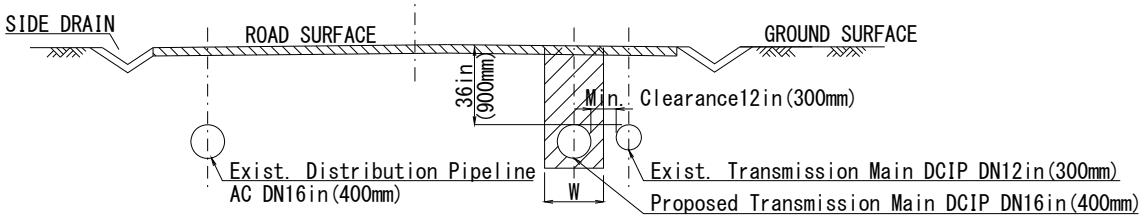
5) Position of Pipe Laying

Typical cross sections of the proposed water transmission main are shown in Figure 2-2-18 to Figure 2-2-22. In general, the additional water transmission main is laid in parallel with the existing water transmission main at the minimum clearance of 12in (300mm).



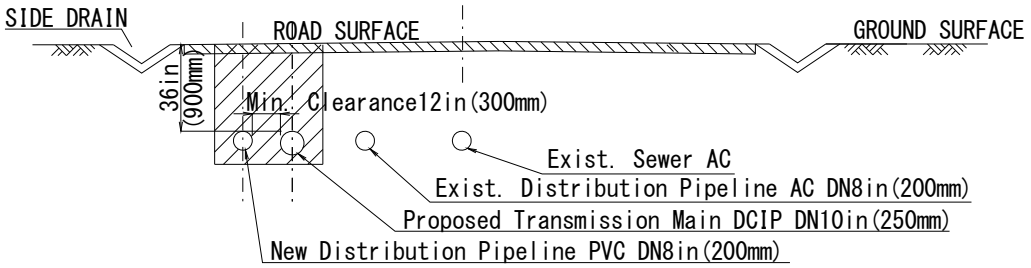
Source: JICA Survey Team

Figure 2-2-18 Typical Cross Section of Proposed Water Transmission Main-1 (KAWTP - KB Bridge at Airai side)



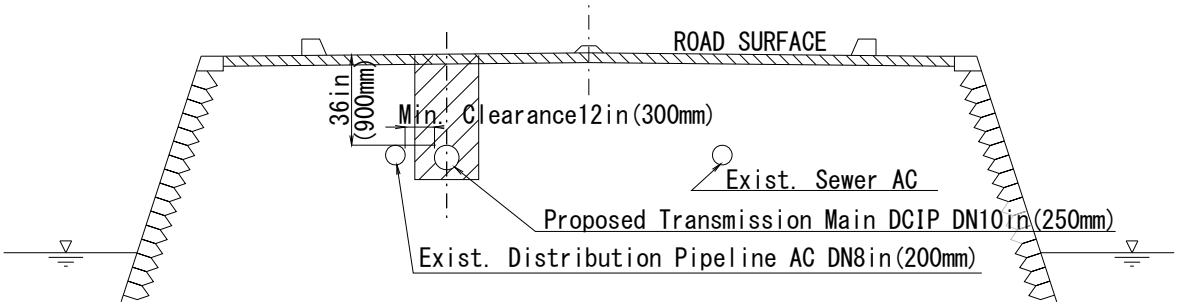
Source: JICA Survey Team

Figure 2-2-19 Typical Cross Section of Proposed Water Transmission Main-2 (KB Bridge at Koror side - Ngerkesoaol service tank branch)



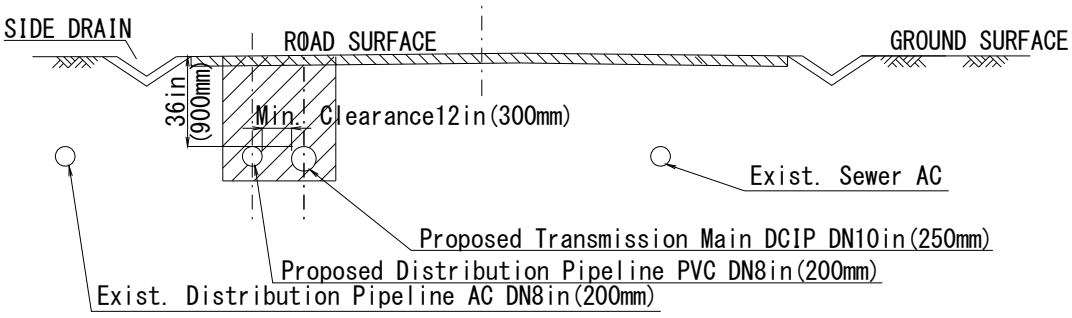
Source: JICA Survey Team

Figure 2-2-20 Typical Cross Section of Proposed Water Transmission Main-3 (PVA intersection – Minatobashi Bridge)



Source: JICA Survey Team

Figure 2-2-21 Typical Cross Section of Proposed Water Transmission Main-4 (Malakal Causeway)



Source: JICA Survey Team

Figure 2-2-22 Typical Cross Section of Proposed Water Transmission Main-5 (Malakal causeway – Malakal service tank)

6) Air Valve, Drain Valve, Sluice Valve

Drain and air valves are installed at the bottom and salient points respectively. Considering easiness for O&M, sluice valves are installed at the start and end points of the proposed route and at every 1km to 3km interval of the proposed route in addition to branches and drains.

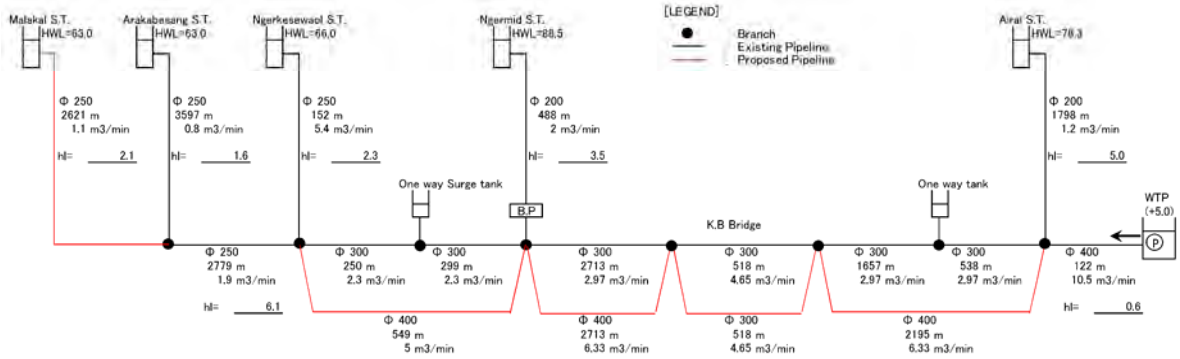
7) Examination of Water Hammer

When power supply for pumps is shut off suddenly for any reason, rapid pressure surge/drop, namely water hammer, occurs in a pressured pipe. When the value of water hammer exceeds the allowable level, it will cause serious accidents, such as breakage of a pipelines. Accordingly, it is necessary to calculate the pressure fluctuation range at the time of power supply interception, and to take a necessary countermeasure if it is harmful.

At present, two (2) of one-way surge tanks are installed in the existing pipeline (along the route of KAWTP up to Arakabesang service tank) as a countermeasure against the water hammer.

In the Project, the proposed water transmission main is laid in parallel with the existing one. Although the total flow increases to 4MG/day (15,140m^3/day), the surge tanks for the existing pipeline is enough because the water flow in the pipeline decreases by the additional one.

Accordingly, the countermeasure against the water hammer is examined for the additional pipeline. The examination model is shown in Figure 2-2-23.

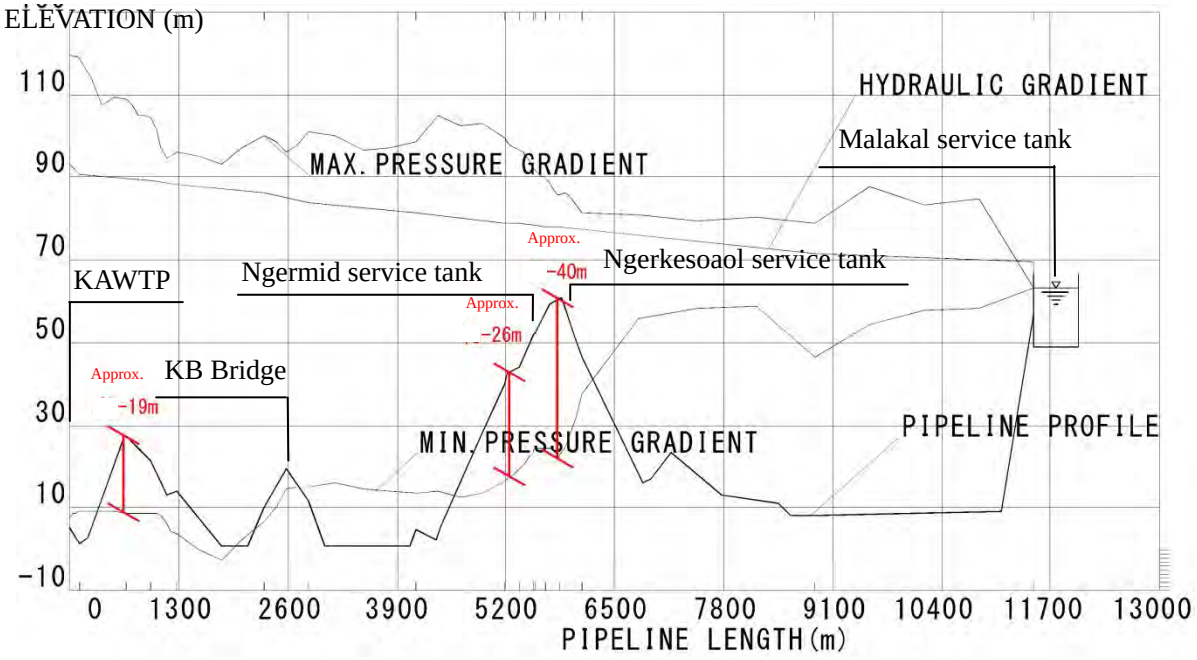


Source: JICA Survey Team

Figure 2-2-23 Water Hammer Examination Model

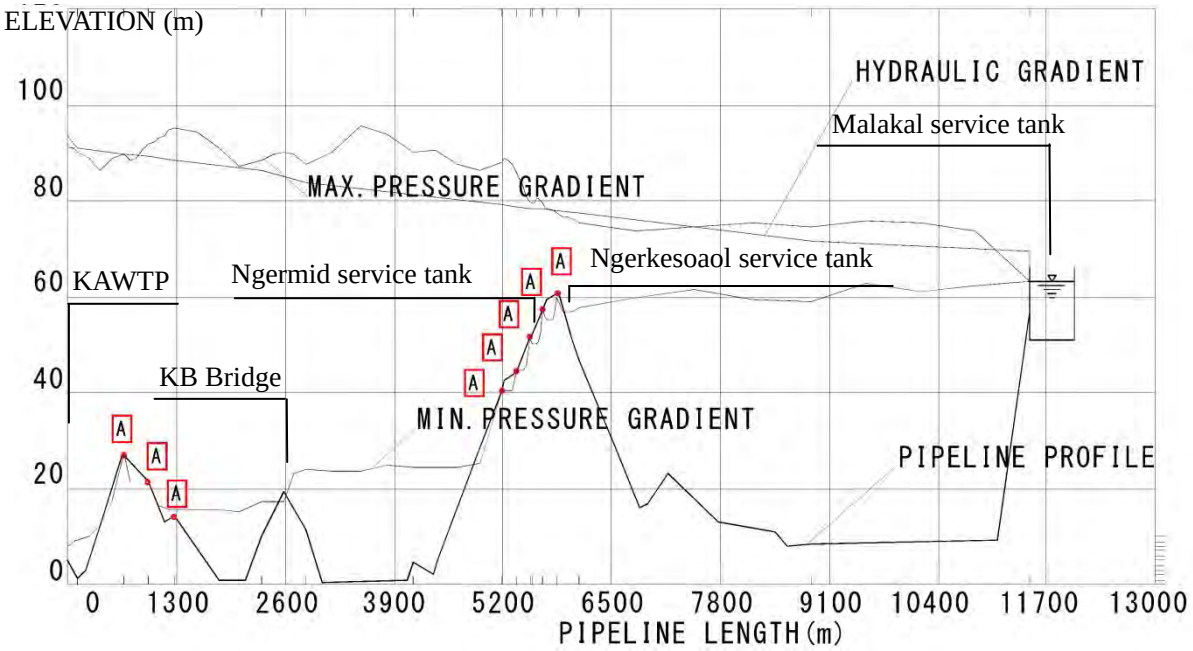
The examination result of water hammer (without any countermeasures) is shown in Figure 2-2-24. It shows the necessity of countermeasures because the negative pressures of approximately -19m to -40m can be generated in the pipeline between KAWTP and branching point to Ngerkesoaol service tank.

The negative pressure is able to be eliminated by installing eight (8) rapid air valves (Diameter of 75mm) as the countermeasure against the water hammer. Among them, three (3) valves are installed between KAWTP and KB Bridge. And the remaining five (5) valves are installed between branching points to Ngermid service tank and Ngerkesoaol service tank as shown in Figure 2-2-25.



Source: JICA Survey Team

Figure 2-2-24 Water Hammer Examination Result (Without Countermeasure)



Source: JICA Survey Team

Figure 2-2-25 Water Hammer Examination Result (With Countermeasure)

8) Attached Pipe to Minatobashi Bridge

To lay the water transmission main to Malakal Island, it should cross over the channel between Koror and Malakal Islands along the Minatobashi Bridge. Since BPW requires to attach the water transmission main to Minatobashi Bridge, impact on the bridge by the pipeline installation is examined as follows.

a) Current Condition of Minatobashi Bridge

Minatobashi Bridge was replaced in 1979, and repaired with the protecting coat on steel pipe piles and pile vents[1] as a part of the widening and repairing project of Malakal causeway, which was implemented by Japan's Grant Aid (the Project for Improvement of Inter-Island Access Road) in November, 2006.

Presently, any particular structural defects are not found although some parts of surface on steel pipe piles are affected by tidal current and peeled off.

[Left] Minatobashi Bridge on the Malakal Island Side, [Right] Overview of Superstructure and Pile Vent Bridge Column of Minatobashi Bridge
Source: JICA Survey Team

Figure 2-2-26 Condition of Minatobashi Bridge

[1] Pile Vent : a structure of the bridge pier to receive the superstructure load by fixing the top of steel pipe pile with RC-made beam

b) Outline of Review for Acceptable Bearing Capacity of Minatobashi Bridge

As for the new water transmission main to Malakal Island, a pipeline of DCIP DN10in (250mm) will be laid. The said pipeline is to be attached to Minatobashi Bridge. The followings are the outline review of the influences caused by increased loads due to pipeline to be attached.

Increased loads by DCIP DN10in (250mm) to be attached

The weight with filled water of the proposed pipeline is 0.98kN/m. Minatobashi Bridge consists of three (3) spans with the intervals of 68ft 6in (20.879m), 70ft (21.336m), and 68ft 6in (20.879m), respectively. The formula below is for the maximum increased weight working to pile vent of the bridge columns. Since the weight for a half-length between the bridge columns should be considered for the load to a pile vent, the load to a pile vent is calculated as 20.7kN for maximum increasied load.

0.48kN/m (weight of pipe) + 0.50kN/m (weight of water) = 0.98kN/m
0.98kN/m x (20.879m + 21.336m) / 2 =20.7kN
20.7 /3 = 6.9kN (per one steel pipe column)

Bearing Capacity and Stress on the Existing Bridge Pile

In the Basic Design of the "Project for Improvement of Inter-Island Access Road in Republic of Palau (2004)", the bearing capacity and stress of the existing bridge pile were studied. It was found out that a compressed load per steel pipe pile was critical on bridge transverse direction. Accordingly, the Project will conduct a study on compressed load per pile for the bridge transverse direction with considerations of the increased load by the attached pipes.

Table 2-2-24 Compressed Load per Steel Pipe Column (Bridge Transverse Direction)

Current Weight	Increased Weight	Total Weight	Acceptable Bearing Capacity
1,022kN	6.9 kN	1,028.9 kN	1,036 kN

Source: JICA Survey Team

As shown in Table 2-2-24, the compressed load is within the acceptable range. The sound condition of main girder is also confirmed through visual inspection and hearing survey. Consequently, it is concluded that the bridge-attached pipeline will be possible for Minatobashi Bridge.

c) Location of Bridge-Attached Pipe

As shown in Figure 2-2-27, the sewer is attached on the west side of Minatobashi Bridge. On the east side, there are two water distribution pipelines attached to the bridge (DN4in: 100mm each). As a result of consultation of BPW, it is concluded to attach the proposed pipeline on the east side of the bridge.

[Left] West Side of Minatobashi Bridge and Existing Sewer, [Right] East Side of Minatobashi Bridge and Existing Water Distribution Pipes (DN4in: 100mm x 2)

Source: JICA Survey Team

Figure 2-2-27 Existing Attached Pipes at Minatobashi Bridge

9) Section of Rock Excavation

The soil condition relating to the excavation work for the proposed water transmission main is generally lateritic (cohesive soil). The limestone is, however, found in the section for 440m from the western side of Airai causeway. The result of test pit survey shows that the soil consists of surface soil (up to GL-20cm), gravel (up to GL-90cm), and limestone (below GL-90cm). Accordingly, the rock excavation is required for the mentioned section to lay the pipeline.

[Left] Outcrop of Limestone (West Side of Road); [Right] Test Pit Survey
Source: JICA Survey Team

Figure 2-2-28 Section of Rock Excavation

(4) Re-pavement of Road

All of the proposed water transmission mains are laid at the national road. As a result of discussion with BPW, the re-pavement is proposed as shown in Table 2-2-25 for the transmission main, including parallel / simultaneous laying with distribution pipelines.

Table 2-2-25 Re-pavement Method

No.	Section	Pipe Laying Method	Re-pavement Method
1	KAWTP - Ngermid Service Tank Branch	Single installation of transmission pipeline	Re-pavement for excavation width plus influenced width of 20cm on each side of trench.
2	Ngermid Service Tank Branch - Ngerkesoaol Service Tank Branch	Parallel installation of transmission and distribution pipelines	Temporary re-pavement for excavation width, then scraping & overlaying for entire width of road.
3	PVA Intersection – Malakal Service Tank	Simultaneous installation of transmission and distribution pipelines	Temporary re-pavement for excavation width, then scraping & overlaying for entire width of road. (“Scraping & overlaying” will be conducted for half width of road for 220m at the southern edge of Malakal Island since no lateral connection is provided.)

Source: JICA Survey Team

2-2-2-5 Water Distribution Zones

(1) Water Supply Volume

1) Design Maximum Daily Water Supply

a) Records of Billed Water at Each Distribution Area

Billed water of Koror-Airai water supply system is being recorded at twelve (12) hamlets respectively, namely a) Airai, b) Meketii, c) Ikelau, d) Medalaii (including Malakal Island), e) Ngerbeched, f) Idid, g) Dngeronger, h) Iyebukl, i) Ngerkesoaol, j) Ngerchemai, k) Meyuns (including Arakabesang) and l) Ngermid. The volume of billed water from June to July 2013 is able to be allocated to the existing and proposed water distribution zones as shown in Table 2-2-26 and Table 2-2-27.

Table 2-2-26 Billed Water at Existing Water Distribution Zones from June to July 2013

Area			Amount of Revenu Water [June-July,2013]					Amount of Revenue Water in each area						
			Billed usage in 1,000gals (flat rate) Domestic	Billed usafe in 1,000gals (Meterd) Domestic	Billed usafe in 1,000gals (flat rate) Non-Domestic	Billed usafe in 1,000gals (Meterd) Non-Domestic	Usage Totals	Direct from KAWTP	Airai	Ngermid	Ngerkesoaol	Arakabesang	Malakal	Total
Airai State	No.1	Airai	1,974,460	3,557,690	266,710	1,186,400	6,985,260	1,397,052	5,588,208	-	-	-	-	6,985,260
Koror State (Hamlets)	No.2	Meketii	1,709	1,011,480	-	931,660	1,944,849	-	-	-	1,944,849	-	-	1,944,849
	No.3	Ikelau	-	989,930	-	1,052,510	2,042,440	-	-	-	2,042,440	-	-	2,042,440
	No.4	Medalaii+Malakal	12,820	3,622,390	6,152,180	11,423,910	21,211,300	-	-	-	21,211,300	-	-	21,211,300
	No.5	Ngerbeched	25,640	4,277,820	400,520	1,432,240	6,136,220	-	-	-	6,136,220	-	-	6,136,220
	No.6	Idid	-	1,779,070	38,200	617,580	2,434,850	-	-	-	2,434,850	-	-	2,434,850
	No.7	Dngeronger	-	892,710	-	2,863,350	3,756,060	-	-	-	3,756,060	-	-	3,756,060
	No.8	Iyebuki	-	1,810,830	31,410	312,410	2,154,650	2,154,650	-	-	-	-	-	2,154,650
	No.9	Ngerkesoaol	-	1,857,750	-	272,200	2,129,950	1,490,965	-	-	638,985	-	-	2,129,950
	No.10	Ngerchemai	-	3,664,640	96,860	491,410	4,252,910	4,252,910	-	-	-	-	-	4,252,910
	No.11	Meyuns+Arakabe	-	3,048,230	334,820	1,351,590	4,734,640	-	-	-	1,893,856	2,840,784	-	4,734,640
	No.12	Ngermid	-	2,959,740	24,610	1,071,000	4,055,350	1,419,373	-	2,635,978	-	-	-	4,055,351
		Total	2,014,629	29,472,280	7,345,310	23,006,260	61,838,479	10,714,950	5,588,208	2,635,978	40,058,560	2,840,784	-	61,838,479

Source: JICA Survey Team

Table 2-2-27 Billed Water at Proposed Water Distribution Zones from June to July 2013

Area			Billed Water Volume [June-July,2013]					Billed Water Volume in each Distribution Zone						
			Billed usage in 1,000gals (flat rate) Domestic	Billed usage in 1,000gals (Meterd) Domestic	Billed usage in 1,000gals (flat rate) Non-Domestic	Billed usage in 1,000gals (Meterd) Non-Domestic	Usage Totals	Direct from KAWTP	Airai	Ngermid	Ngerkesoaol	Arakabesang	Malakal	Total
Airai State	No.1	Airai	1,974,460	3,557,690	266,710	1,186,400	6,985,260	-	6,985,260	-	-	-	-	6,985,260
Koror State (Hamlets)	No.2	Meketii	1,709	1,011,480	-	931,660	1,944,849	-	-	-	1,944,849	-	-	1,944,849
	No.3	Ikelau	-	989,930	-	1,052,510	2,042,440	-	-	-	2,042,440	-	-	2,042,440
	No.4	Medalaii+Malakal	12,820	3,622,390	6,152,180	11,423,910	21,211,300	-	-	-	14,847,910	-	6,363,390	21,211,300
	No.5	Ngerbeched	25,640	4,277,820	400,520	1,432,240	6,136,220	-	-	-	6,136,220	-	-	6,136,220
	No.6	Idid	-	1,779,070	38,200	617,580	2,434,850	-	-	-	2,434,850	-	-	2,434,850
	No.7	Dngeronger	-	892,710	-	2,863,350	3,756,060	-	-	-	3,756,060	-	-	3,756,060
	No.8	Iyebuki	-	1,810,830	31,410	312,410	2,154,650	-	-	2,154,650	-	-	-	2,154,650
	No.9	Ngerkesoaol	-	1,857,750	-	272,200	2,129,950	-	-	1,490,965	638,985	-	-	2,129,950
	No.10	Ngerchemai	-	3,664,640	96,860	491,410	4,252,910	-	-	4,252,910	-	-	-	4,252,910
	No.11	Meyuns+Arakabe	-	3,048,230	334,820	1,351,590	4,734,640	-	-	-	-	4,734,640	-	4,734,640
	No.12	Ngermid	-	2,959,740	24,610	1,071,000	4,055,350	-	-	4,055,350	-	-	-	4,055,350
		Total	2,014,629	29,472,280	7,345,310	23,006,260	61,838,479	0	6,985,260	11,953,875	31,801,314	4,734,640	6,363,390	61,838,479

Source: JICA Survey Team

(2) Maximum Daily Water Supply and Maximum Hourly Water Distribution

Design maximum daily water supplies for the existing and proposed water distribution zones are calculated with the ratio of billed water in each distribution zone.

Multiplying the design maximum hourly coefficient on the daily design maximum water supply, the design maximum hourly water distribution is calculated.

It is unable to confirm the fluctuations of daily / hourly water distributions per water distribution zone because district flow meters are not installed at the service tanks in Koror-Airai water supply system. Consequently, it is not possible to calculate the actual maximum hourly coefficient. Accordingly, the design maximum hourly coefficient is estimated in accordance with the Japan's guideline for water supply facility design (published by JWWA, 2012).

Since the Project site is residential and commercial areas, the following formula is commonly applied for calculation of the design maximum hourly coefficient in accordance with the Japan's guideline.

$$K = 1.8665 \times (Q/24)^{-0.0214}$$

where,

K: Design Maximum Hourly Coefficient

Q: Water Distribution Flow (m^3/day)

The recorded daily maximum water supply is 3.95MG/day (14,951m^3/day) in 2013. And NRW ratio is estimated at 48%. Accordingly, the billed water is estimated at 2.05MG/day (7,759m^3/day) for the day of maximum water supply.

NRW (48%)	1.90MG/day	(Constant)
Billed water (52%)	2.05MG/day	(Fluctuating momentarily)
Total water supply (100%)	3.95MG/day	

Substituting "Q" with 2.05 MG/day in the above formula, the coefficient is derived as 1.65.

$$K = 1.8665 \times (2.05\text{MG/day (i.e.7,759.25m}^3\text{/day)}/24)^{-0.0214} = 1.65$$

Considering the total water supply (3.95MG/day), the coefficient is derived as 1.34.

$$(1.90\text{MG (NRW)} + 2.05\text{MG (billed water)} \times 1.65))/3.95\text{MG} = 1.337$$

Accordingly, "1.3" will be appropriate for the design maximum hourly coefficient.

Using the design maximum hourly coefficient of 1.3, the design maximum hourly water distribution for the existing and proposed water distribution zones are estimated as shown in Table 2-2-28.

Table 2-2-28 Maximum Daily Supply and Maximum Hourly Supply for Existing and Proposed Distribution Zones

a) Existing

Distribution Zone		Direct from KAWTP	Airai	Ngermid	Ngerkesoaol	Arakabesang	Malakal	Total
Revenue water (G) [June-July,2013]		10,714,950	5,588,208	2,635,978	40,058,560	2,840,784	-	61,838,479
Maximum Daily Water Supply	MG/d	0.69	0.36	0.17	2.60	0.18	-	4.0
	(m^3/d)	(2,623)	(1,368)	(645)	(9,808)	(696)	-	(15,140)
	Ratio (%)	17.3%	9.0%	4.3%	64.8%	4.6%	-	100%
Maximum Hourly Water Supply	Hourly Factor	1.3	1.3	1.3	1.3	1.3	-	1.3
	MG/d	0.90	0.47	0.22	3.38	0.23	-	5.2
	(m^3/d)	(3,410)	(1,778)	(839)	(12,750)	(905)	-	(19,682)

b) Proposed

Distribution Zone		Direct from KAWTP	Airai	Ngermid	Ngerkesoaol	Arakabesang	Malakal	Total
Revenue water(G) [Based on June-July,2013]		-	6,985,260	11,953,875	31,801,314	4,734,640	6,363,390	61,838,479
Maximum Daily Water Supply	MG/d	-	0.45	0.77	2.06	0.31	0.41	4.0
	(m^3/d)	-	(1,710)	(2,927)	(7,786)	(1,159)	(1,558)	15,140
	Ratio (%)	-	11.3%	19.3%	51.4%	7.7%	10.3%	100%
Maximum Hourly Water Supply	Hourly Factor	-	1.3	1.3	1.3	1.3	1.3	1.3
	MG/d	-	0.59	1.00	2.68	0.40	0.53	5.2
	(m^3/d)	-	(2,223)	(3,805)	(10,122)	(1,507)	(2,025)	(19,682)

Notes: The maximum hourly water supply shows a value converted into a flow rate per 24 hours
Source: JICA Survey Team

(3) Pipeline Network Analysis

1) Design Conditions

a) Maximum Hydrostatic Pressure

Considering the locations and topography of the existing service tanks and the types of valves and pipes in the existing networks, it is appropriate to determine the maximum hydrostatic pressure at 100psi (0.76MPa). It is also the reference pressure of PPUC for the water distribution pipelines.

b) Minimum Dynamic Water Pressure

The minimum dynamic water pressure is 20psi (0.14MPa) which is the reference pressure of PPUC for the water distribution pipelines.

c) Hydraulic Calculation Formula (Calculation of Head Loss)

Hazen-Williams formula is applied to calculate the head losses on water distribution pipelines. The head losses are calculated per water distribution zone, utilizing the design maximum hourly water distribution.

d) Hazen-Williams Coefficient

Hazen-Williams coefficient varies depending on the roughness of inner surface, bending, and the number of branch. In the Project, Hazen-Williams coefficient (C) is assumed as 110. It includes losses at bends, valves and other factors for friction.

e) Water Level of Service Tanks

The minimum dynamic water pressure is calculated with the low water level (hereinafter referred to as “LWL”) of each tank. Similarly, the maximum hydrostatic pressure is also calculated with the high water level (hereinafter referred to as “HWL”). Table 2-2-29 shows the water levels of the tanks.

Table 2-2-29 Water Levels of Service Tanks

Service Tanks	HWL	LWL
1. Airai	261ft (78.3m)	221ft (66.3m)
2. Ngermid	295ft (88.5m)	255ft (76.5m)
3. Ngerkesoaol	220ft (66.0m)	188ft (56.4m)
4. Arakabesang	210ft (63.0m)	190ft (57.0m)
5. Malakal	210ft (63.0m)	190ft (57.0m)

Source: JICA Survey Team

2) Outline of Re-arrangement of Water Distribution Zones and Network Analysis

a) Viewpoints for Re-arrangement

Considering the current issues on the existing water distribution zones and the results of pipe network analysis, the following points should be improved by the re-arrangement of water distribution zones:

To ensure the appropriate water pressure and stable water supply in Ngerkesoaol water distribution zone

The low service pressure area, namely Ngerbeched area, should be improved by the re-arrangement. It includes the establishment of the proposed Malakal water distribution zone and its separation from Ngerkesoaol zone.

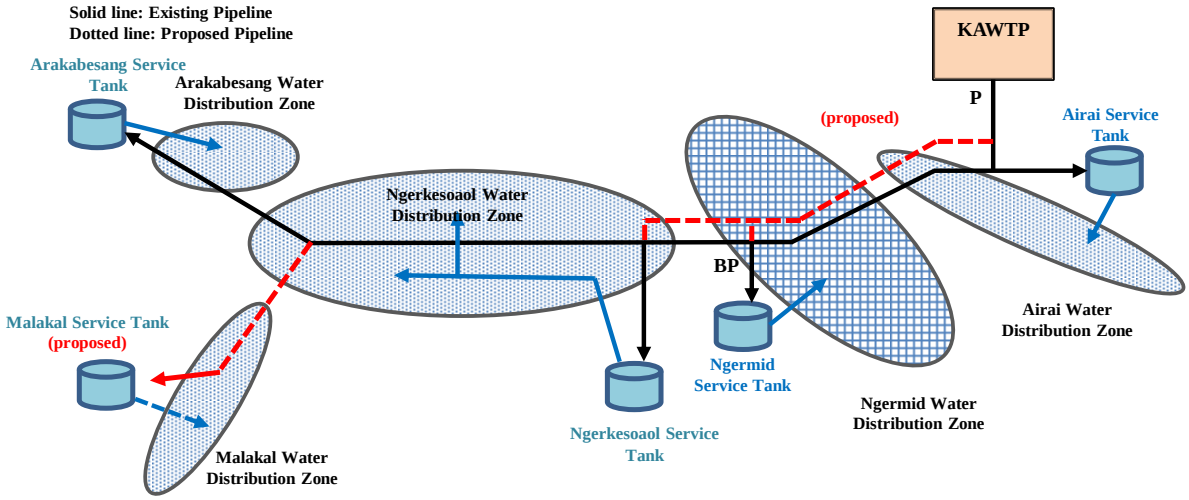
Furthermore, the share of water distribution volume for Ngerkesoaol water distribution zone should be reduced through expansion of Arakabesang zone.

Stable water supply should be also ensured in Malakal Island by the re-arrangement. The treated water should be transmitted to Malakal service tank through the proposed exclusive transmission main.

To ensure the stability of water supply and the balance of water distribution by discontinuation of the direct water distribution zone from KAWTP

Airai water distribution zone should be expanded to cover the whole Airai State. Ngermid water distribution zone should be also expanded to the Koror side of KB Bridge. Hereby, the direct distribution zone is eliminated, and the water transmission pumps in KAWTP can be operated stably, and Ngerkesoaol water distribution zone will be reduced in covering area.

Figure 2-2-29 shows the schematic diagram of the re-arrangement of water distribution zones.



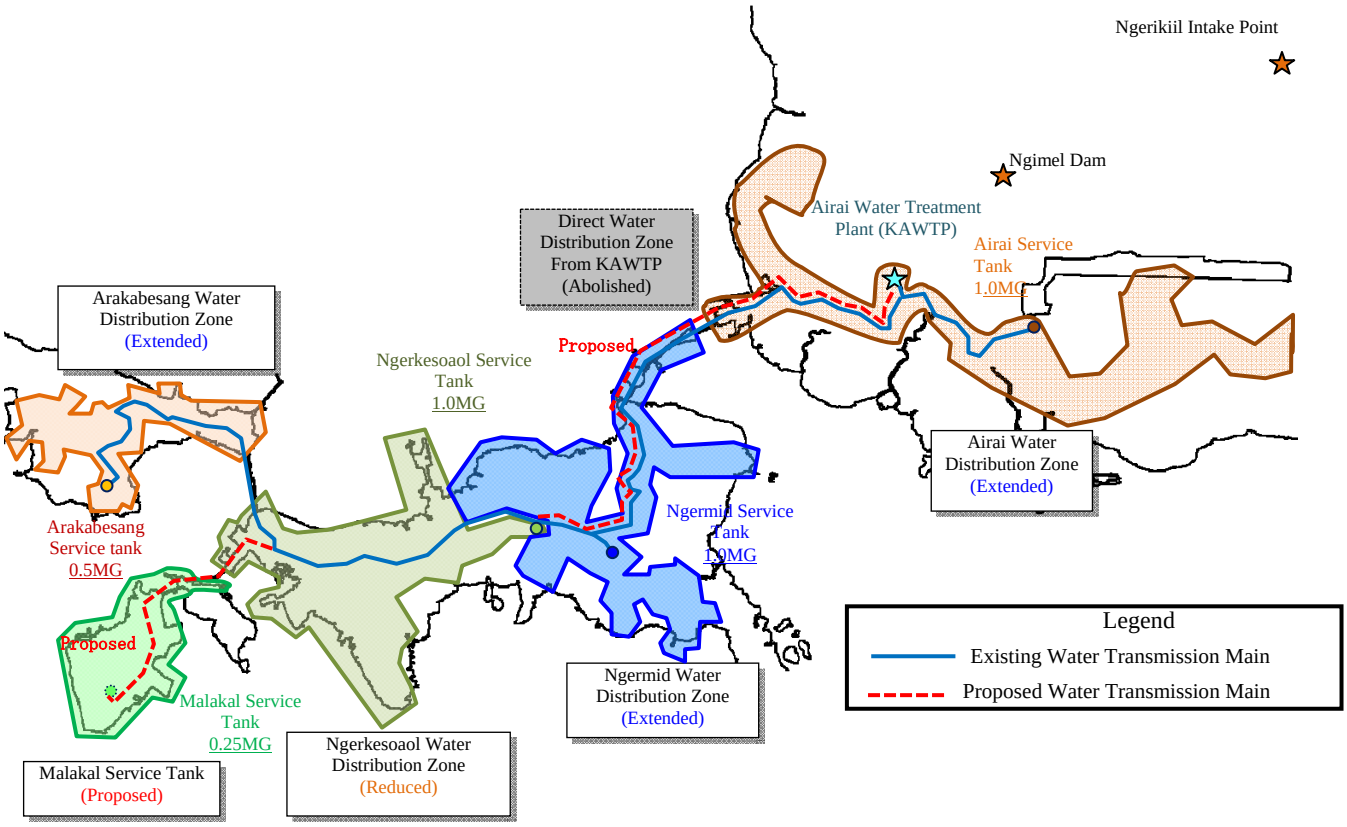
Source: JICA Survey Team

Figure 2-2-29 Schematic Diagram of Re-arrangement of Water Distribution Zones

b) Result of Analysis for Proposed Water Distribution Network

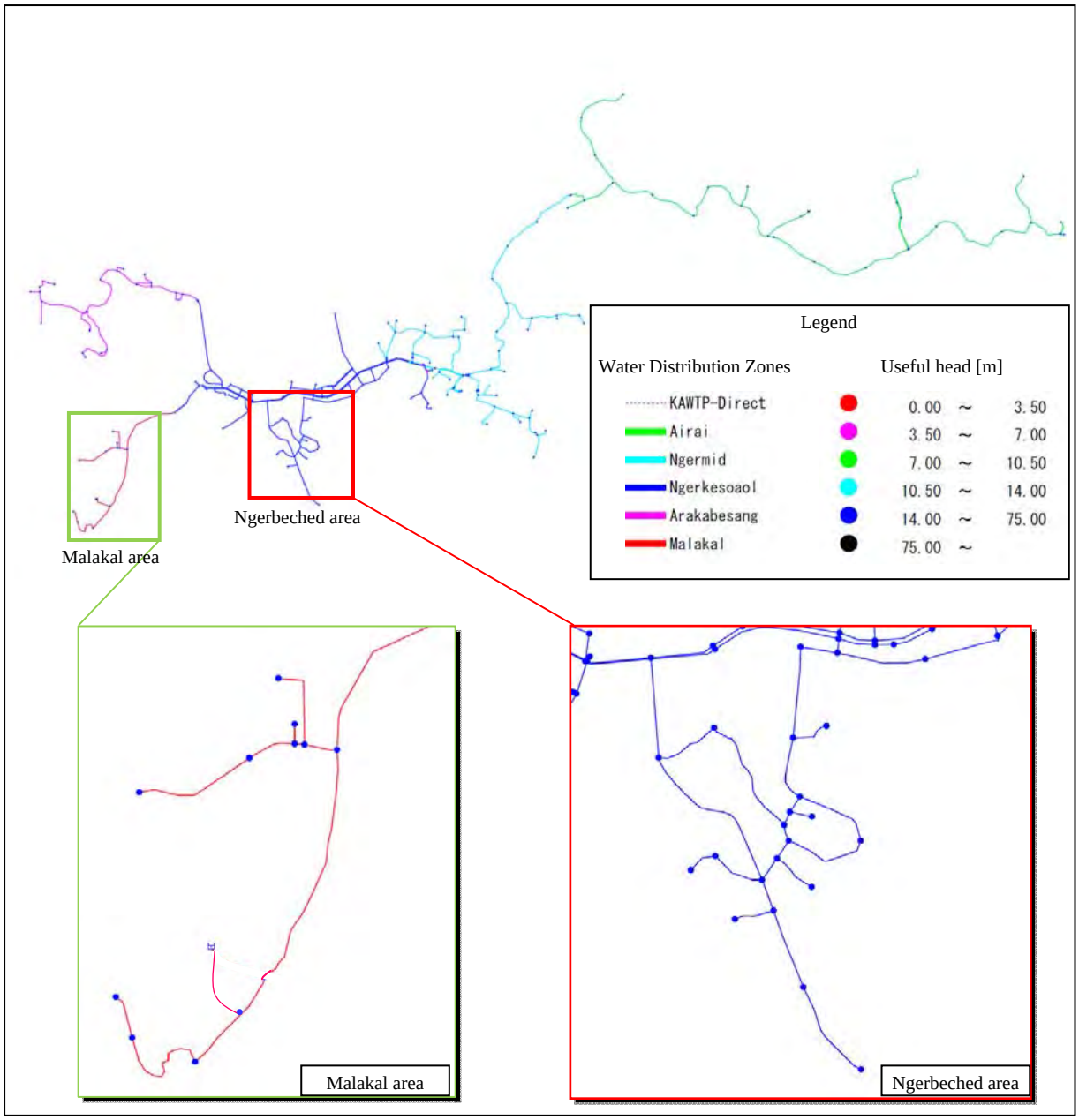
Figure 2-2-30 and Figure 2-2-31 show the results of pipe network analysis based on the re-arrangement of water distribution zones. They indicate the following improvement in the water distribution system.

- In Ngerkesoaol water distribution zone, which is the largest among the five (5) zones, the water pressure for the water distribution pipeline is increased by disconnection of Malakal Island and expansion of Arakabesang zone. In particular, the minimum dynamic water pressure will be 20 psi (0.14MPa) or more in the low pressure area.
- The maximum hydrostatic pressure will be less than 110 psi (0.76MPa) in Iyebukel and Ngerchemai areas in the north of Ngerkesoaol Service Tank by discontinuation of the direct water distribution zone.
- Enough water pressure in the western area of Airai State will be ensured even though the direct water distribution zone is merged with Airai zone.
- The issue of the low pressure areas in Malakal Island will be solved.



Source: JICA Survey Team

Figure 2-2-30 Proposed Water Supply System (Water Distribution Zone)



Source: JICA Survey Team

Figure 2-2-31 Calculation Result for Proposed Water Distribution Network: Water Pressure Distribution Map (Minimum Dynamic Water Pressure)

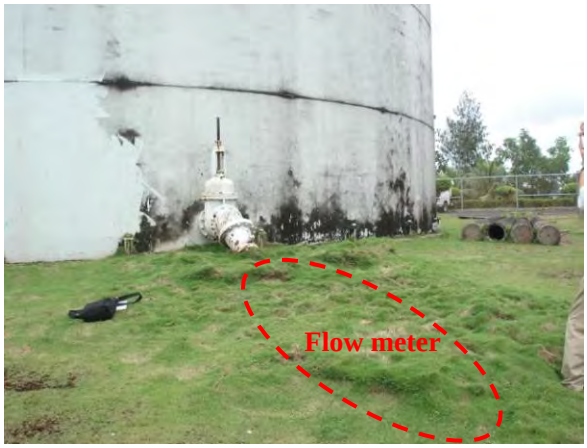
(1) District Flow Meters at Service Tanks

District flow meters are currently not installed in all service tanks. They should be installed at the outlet of the service tanks to monitor the water distribution volume. The meters are to be utilized for monitoring / controlling the inflow/outflow volume of the service tanks and calculating NRW.

1) Location of Flow Meters

Figure 2-2-32 shows the locations of the flow meters to be installed. Since Airai and Ngermid Service Tanks have sluice valves at the outlet for the water distribution pipeline, the flow meters are installed in downstream of the valves. As for Ngerkesoaol and Arakabesang service tanks, concrete valve boxes are currently installed at the outlet of the water distribution pipeline. The flow meters are, therefore, installed after removal of the valve boxes. Figure 2-2-33 shows the schematic diagram for installation of district flow meters.

1. Airai service tank



2. Ngermid service tank

3. Ngerkesoaol service tank

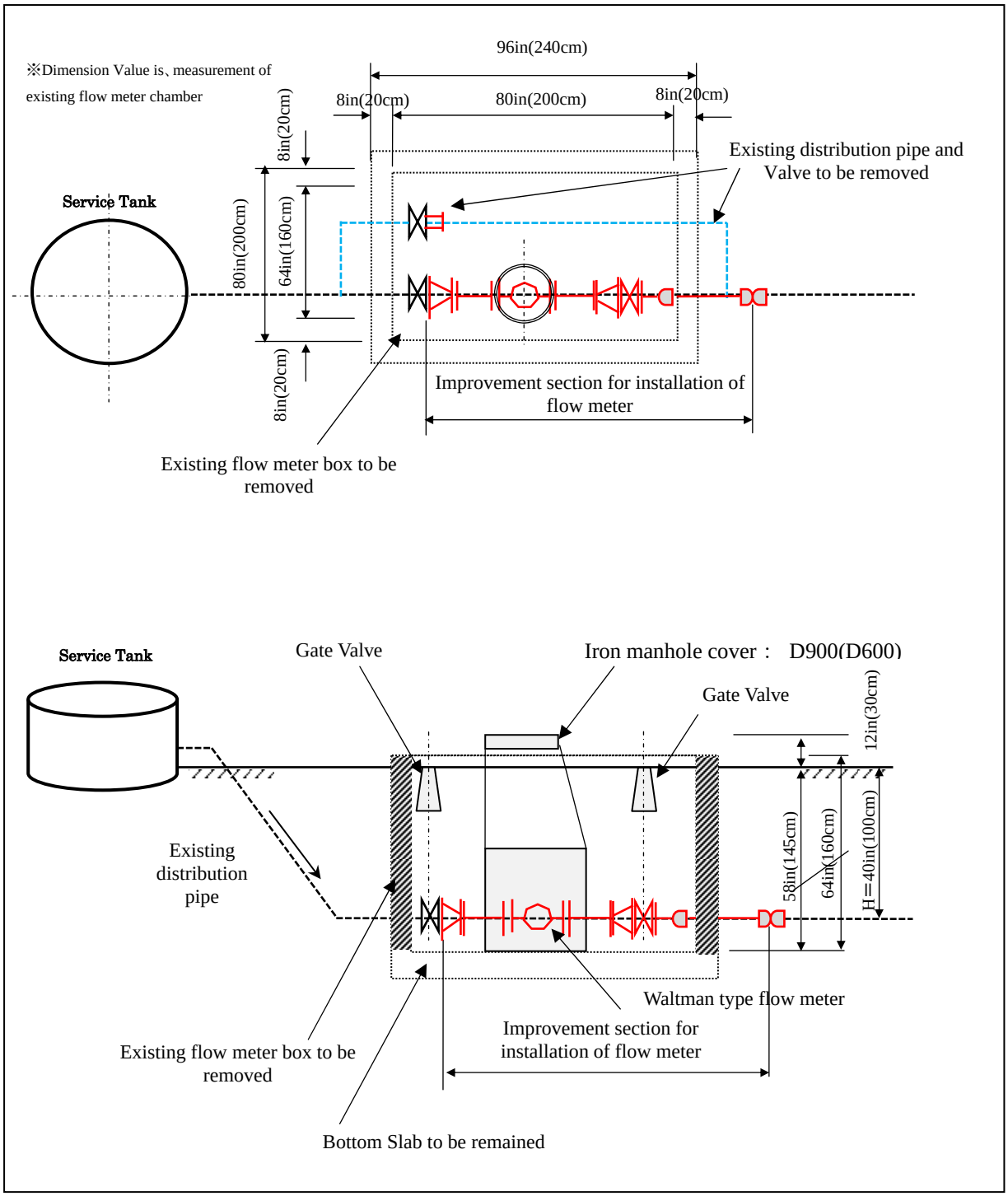
4. Arakabesang service tank

Source: JICA Survey Team

Figure 2-2-32 Installation Locations of Flow Meters

2) Installation Method of Distribution Flow Meters

For installing flow meters, water distribution will be temporarily interrupted.



Source: JICA Survey Team

Figure 2-2-33 Schematic Diagram of Installation of Distribution Flow Meter (Ngerkesoaol and Arakabesang service tanks)

3) Specifications of District Flow Meters

There are some types of water flow meter such as the impeller type, electromagnetic type, and ultrasonic type. Considering cost and easiness of maintenance, the impeller type which requires no electrical devices is proposed.

Considering the allowable measurement range, the size of the flow meters are proposed as shown in Table 2-2-30.

Table 2-2-30 Size of District Flow Meters

Service Tanks	Design maximum hourly supply	Flow meter size	Flow rate range (Minimum-Maximum)
1. Airai	410 G/min (0.59MG/ day)	6in (150mm)	20-3100 G/min
2. Ngermid	694 G/min (1.00MG/ day)	6in (150mm)	20-3100 G/min
3. Ngerkesoaol	1,861 G/min (2.68MG/ day)	8in (200mm)	35-5000 G/min
4. Arakabesang	278 G/min (0.40MG/ day)	6in (150mm)	20-3100 G/min
5. Malakal	368 G/min (0.53MG/ day)	6in (150mm)	20-3100 G/min

Note: Design maximum hourly water supply= Design maximum daily water supply x maximum hourly coefficient as (1.3)
Source: JICA Survey Team

2-2-2-6 Malakal Service Tank

(1) Design Concept

The following are design conditions for Malakal service tank:

- Capacity of a service tank should be calculated in accordance with 12 hour-storage of the design maximum daily water supply. The demand for fire hydrants should be calculated separately and added to the above 12 hours-storage of capacity.
- Malakal service tank should be divided into two (2) parts (2 basins) for maintenance, inspection, cleaning, repair, etc.
- A remote monitoring system for water level, which is the same / similar one as installed at the four (4) existing service tanks in Airai, Ngermid, Ngerkesoaol and Arakabesang, should be installed at Malakal service tank. Accordingly, the staff of water distribution management can manage the water level by the present manner.

1) Capacity of Malakal Service Tank

There is no standard for a capacity of service tank in Palau. Accordingly, the capacity of Malakal service tank is proposed for 12 hour-storage of the design maximum daily water distribution based on Japan's guideline for water supply facility design (published by JWWA, 2012).

As the design maximum daily water distribution is 0.41MG (1,552m^3)/day, the capacity for 12 hours is calculated as 0.21MG (795m^3).

If the service population is under 50,000 per tank, necessary water volume for fire hydrants should be added to the mentioned capacity. The volume of fire hydrants water is proposed for 40 m^3 based on "the standard of water for fire defense" in Japan, which specifies the requirement to ensure 1m^3/min of flow for continuous 40min.

As shown in Table 2-2-31, the capacity of Malakal service tank is determined as a quarter MG (0.25MG : 950m^3).

Table 2-2-31 Design Capacity of the Service Tank

Name of Service Tank	Design Capacity of Service Tank	Construction Site
Malakal service tank	0.25MG (about 950 m^3)	Location adjacent to the existing service tank

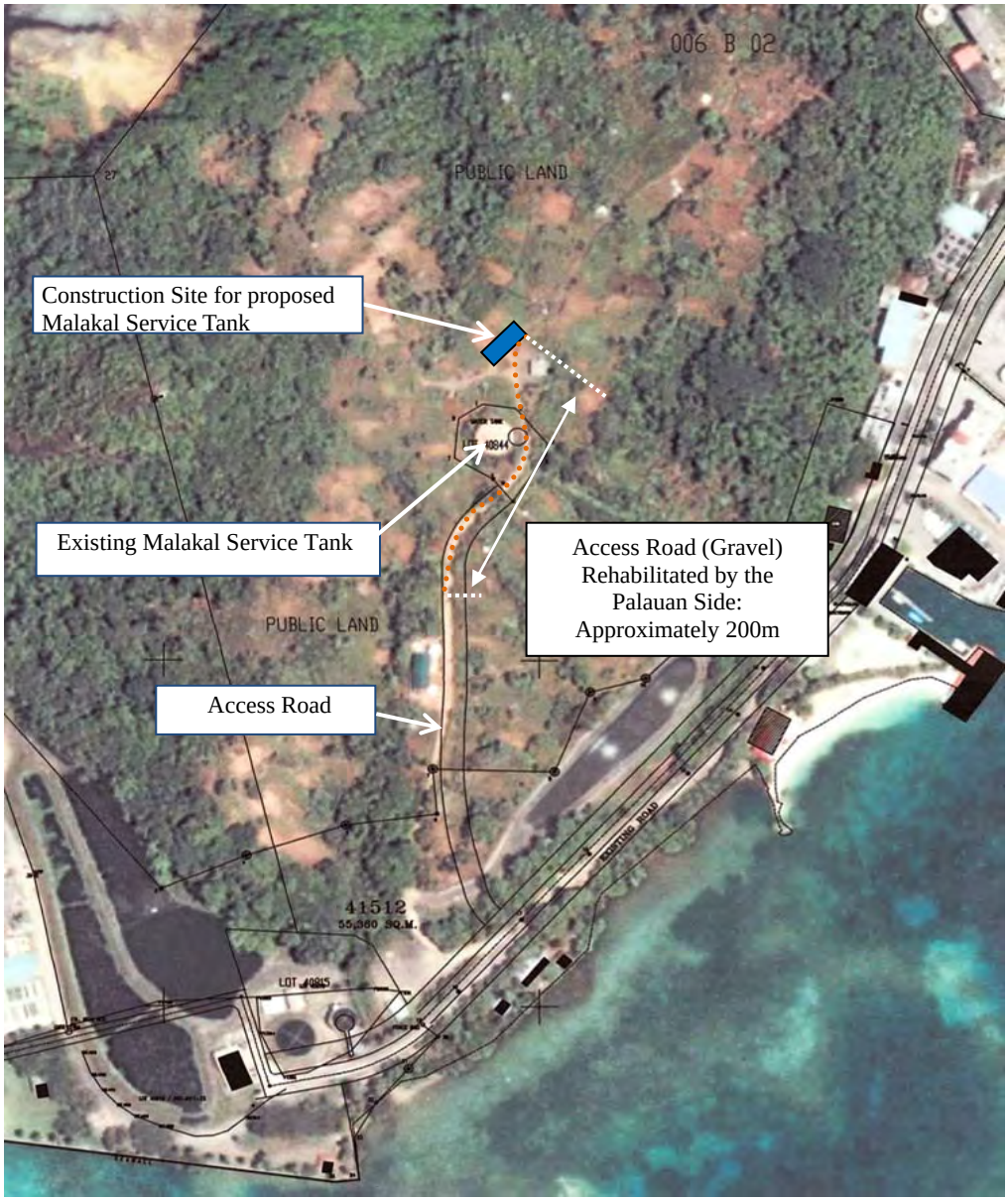
Source: JICA Survey Team

2) Construction Site of Malakal Service Tank

Figure 2-2-34 shows the location of Malakal service tank.

The existing steel-made service tank has not been used for more than 35 years after construction in the late 1970s. Outer surface paint, including roof, is peeled off at the ribbed parts, baseplates and bolts, which are rusty and severely damaged. It is difficult to ensure the durability and water tightness of the tank. Accordingly, another tank is proposed to be constructed instead of the exiting one. As for necessary land, it is confirmed that GoP owns the land for the proposed Malakal service tank including

the existing tank, and the land utilization has been approved for the proposed tank.



Source: Bureau of Land and Survey and Edited by JICA Survey Team

Figure 2-2-34 Location Map of Malakal Service Tank

(2) Style, Size and Material for Malakal Service Tank

Considering the available space, access for transporting construction materials and easiness of O&M, shape, size and material are proposed for Malakal service tank as shown in Table 2-2-31.

Table 2-2-32 Style, Size, and Material for Malakal Service Tank

Name of Proposed Service Tank	Proposed Capacity of Service Tank MG (m^3)	Type	Effective Dimension (LxWxH)	Material	Shape
Malakal service tank	0.25MG (approximately 950 m^3)	On the Ground	32ft-8in (9.8m) x 43ft-4in (13.0m) x15ft-4in (4.6m) x 2 Tanks	RC-made	Rectangle

Notes: H: Net Depth
Source: JICA Survey Team

Maintenance of the painted steel tanks is one of major issues for PPUC. So far, the regular maintenance, such as cleaning and re-painting steel-made structure, has not been conducted sufficiently. Accordingly, RC-made is recommended for the proposed Malakal service tank since it does not require re-painting and frequent O&M works. As for the water tightness, it will be ensured by waterproof coat to be provided inside the tank.

Moreover, PPUC evaluates the RC-made service tanks as appropriate because of the easiness of maintenance, from experiences of the exiting RC-made tanks (rectangular) in Babeldaob Island.

In case of RC-made service tank, it is important to secure access for concrete mixer trucks and heavy construction equipment. Although the existing access road is partly paved by concrete, there are still unpaved parts for 667ft (200m), which become muddy due to heavily rains. PPUC, therefore, plans to cover the unpaved part with gravel before construction of the proposed Malakal service tank.

There are no fence and gate around the existing service tank, and outside peoples are able to enter the site. It results in frequent mischiefs such as scribbles and scratches on the wall of the tank. Therefore, fences and gates should be constructed by PPUC around the proposed Malakal service tank in the Project.

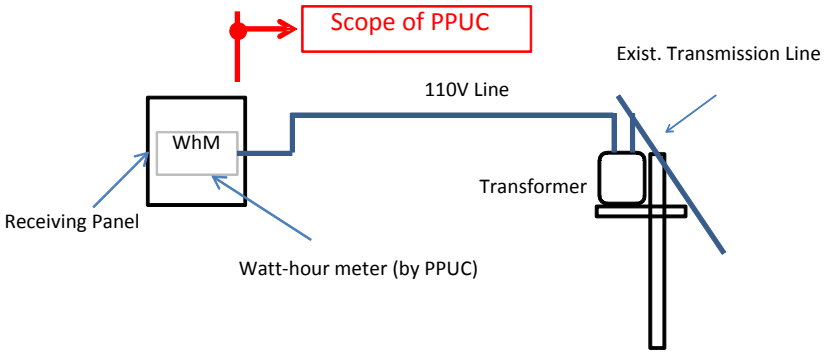
(3) Water Level Monitoring System

In June 2014, PPUC introduced the remote monitoring system for water level of the existing service tanks in Airai, Ngerkesoaol, and Arakabesang. When water level reaches HWL, the monitoring system sends a warning signal to the management staff of water distribution. According to the signal, the staffs control water transmission pumps and inflow valves at service tanks.

Regarding the existing Ngermid service tank, an interlocking automatic switch was introduced at the booster pump in June 2014 to control the water level of tank and booster pump. The system functions presently.

As for the proposed Malakal service tank, it is proposed to introduce the same water level monitoring system as the existing service tanks.

Since the monitoring system requires the electric power, the Palauan side shall construct the facility for leading power (including branching work from the existing distribution panel, wiring work up to the new receiving panel, and installation of watt-hour meter) up to the receiving panel, which is installed by the Japanese side at the proposed Malakal service tank as shown in Figure 2-2-35. Besides, this system is operable in case of power cut by battery system.



Source: JICA Survey Team

Figure 2-2-35 Scope of Work of the Palauan Side on Power Supply at Malakal Service Tank

2-2-2-7 Water Distribution Pipelines

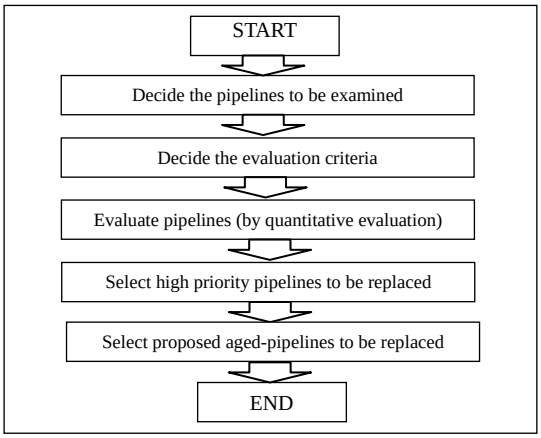
(1) Selection of Proposed Pipelines

1) Selection of Pipelines to be Replaced

All of the existing AC pipes, of which length is 20.3mi (32.5km) in total, should be replaced. It is, however, difficult to replace all pipelines due to difficulties of traffic control and quick budgeting. Therefore, highly prioritized pipelines are selected for the proposed pipelines in the Project.

a) Flow Diagram for Examination of High Priority Pipelines

The order of priority for replacing aged distribution pipelines is determined according to the steps as shown in Figure 2-2-36. The priority is determined as the following section b) to f).



Source: JICA Survey Team

Figure 2-2-36 Flow Diagram of Examination for High Priority Pipelines

b) Pipelines to be Examined

Most of the distribution pipelines in Koror State are made of AC. Those pipelines were installed in the 1940s and 1970s, including pipelines for Arakabesang and Malakal Islands.

The Project selects, therefore, candidates of the pipelines in the central part of Koror State, Arakabesang and Malakal Island for examination.

c) Evaluation Criteria

Based on the information provided by PPUC, the five criteria are determined for priority consideration of pipelines to be replaced as shown in Table 2-2-33.

Table 2-2-33 Evaluating Criteria and Score for Replacement Priority of Distribution Pipelines

Evaluation Criteria	Evaluation Method	Evaluation Score	
A. Pipe type	To confirm strength in pipe material	i) AC pipe	5 points
		ii) Other pipe materials	1 point
B. Number of years since installation	To count the number of years since installation (degree of deterioration)	i) 70 years or more	5 points
		ii) 40 years or more	3 points
		iii) 20 years or more	1 point
		iv) Less than 20 years	0 point
C. Importance of the pipeline	To confirm / measure diameter of the pipeline	i) High (8in: 200mm) -12in: 300mm)	3 points
		ii) Medium (6in: 150mm)	2 points
		iii) Low (4in: 100mm)	1 point
D. Traffic flow	To confirm traffic flow (impact by traffic load)	i) Large (Main Road)	3 points
		ii) Medium (Community road in case of High Traffic Flow)	2 points
		iii) Small (Community road)	1 point
E. Frequency of water leakage	To review records of water leakage	i) Yes	5 points
		ii) No	0 point

Source: JICA Survey Team

d) Evaluation of Pipelines

Numbering nodes for the origin and end of each pipeline, the pipelines are evaluated according to the criteria as shown in Table 2-2-32. Priorities for replacement are categorized as shown in Table 2-2-34. In terms of priority for replacement, high and rather-high occupy 37% of the pipelines. When adding the medium priority pipelines, more than 70% of the pipelines are evaluated as higher priority to be replaced.

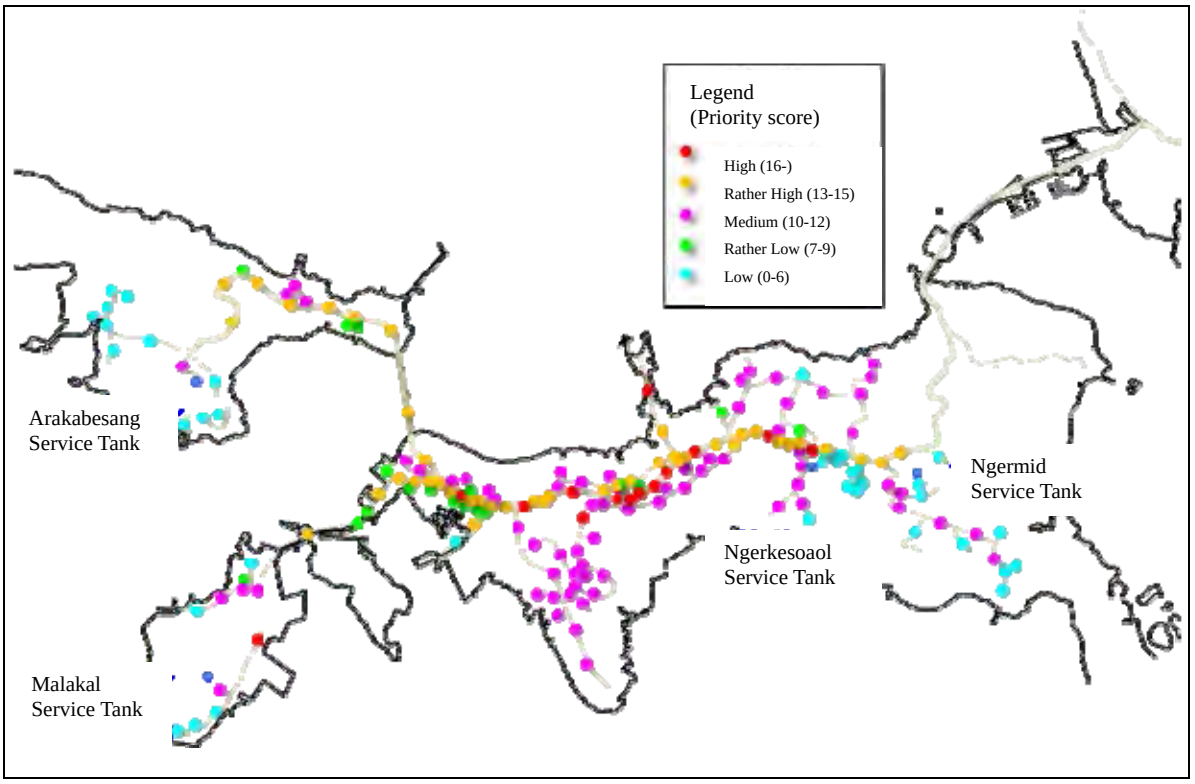
Table 2-2-34 Priority Ranks of Pipelines

Evaluation Score	Priority Rank	Percentage
16 points or more	High	12%
13 to 15 points	Relatively high	25%
10 to 12 points	Medium	36%
7 to 9 points	Relatively low	6%
6 points or less	Low	21%
Total		100%

Source: JICA Survey Team

e) Selection of High Priority Pipelines to be Replaced

Figure 2-2-37 shows the priory scores of the pipelines based on the above evaluation. It shows that the water distribution pipelines in the central part of Koror State, Arakabesang and Malakal Islands are high in priority.



Source: JICA Survey Team

Figure 2-2-37 Priorities for Replacement of Aged Pipelines

f) Selection of Proposed Aged-pipelines to be Replaced

Considering the high-priority pipelines to be replaced, the Project selects the route A to the route J as the proposed aged-pipelines for replacement as shown in Table 2-2-35.

Based on the evaluation results, pipelines in the densely populated area is basically prioritized. Accordingly, the pipelines in the central part of Koror State are to be selected correspondingly. It is preferable in a view of cost-effectiveness.

The Project identify the proposed routes in detail based on branching points, as shown in Table 2-2-35 and Figure 2-2-38 which show highly prioritized pipelines for replacement. Appropriate diameter of each pipeline are confirmed by the aforementioned pipe network analysis.

A route between PVA intersection and the proposed Malakal service tank, excluding Malakal causeway, is highly advantageous for workability and cost efficiency for replacement, since it is to be laid in parallel of the proposed water transmission main and it is possible to lay the two (2) pipelines at the same time.

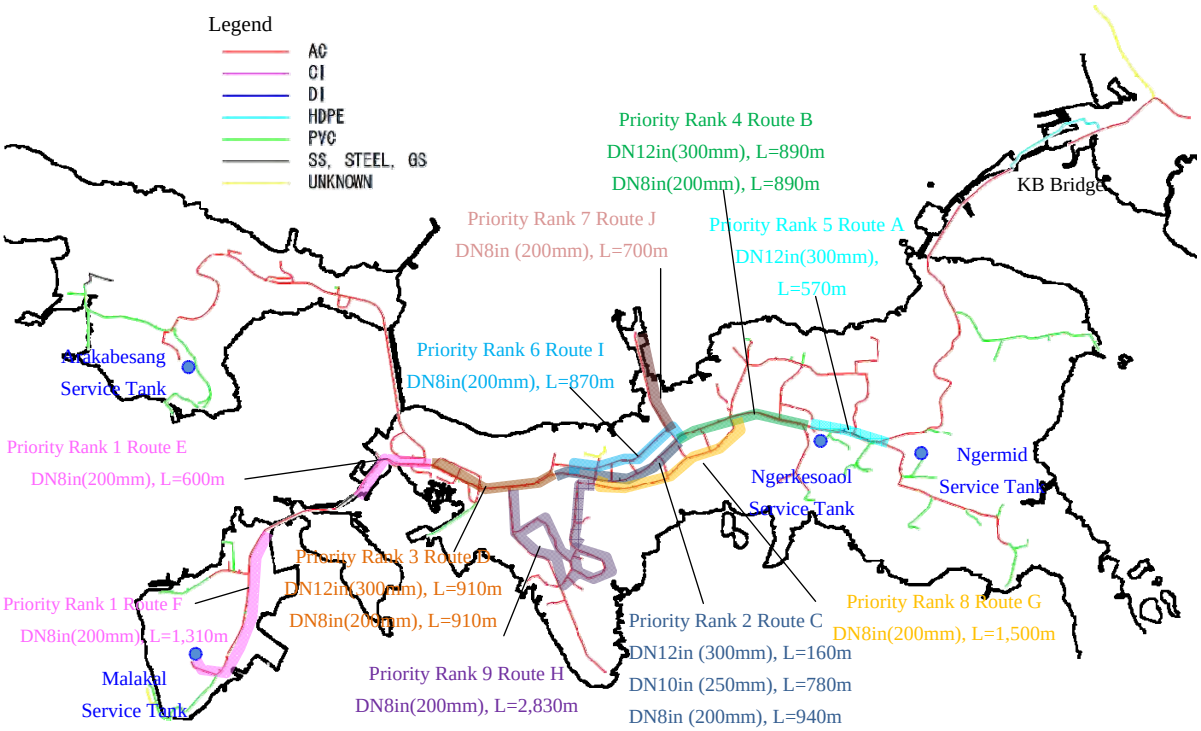
Besides, a dual distribution pipelines system (to lay pipelines at both sides of road) is proposed for the Route C, which is a congested and wider road for three (3) lanes, to ensure easiness of lateral pipe branching.

Table 2-2-35 High Priority Routes of Aged-Pipelines to be Replaced

Priority rank	Route	Existing			Proposed			Remarks
		Diameter		Length	Diameter		Length	
		in	mm	m	in	mm	m	
1	E	8	200	600	8	200	600	➢ National road section between PVA intersection and Malakal service tank ➢ Water leakage accident in the past ➢ Simultaneous pipe laying with water transmission main ➢ Over 40 years aged AC pipes
	F	8	200	1,310	8	200	1,310	
2	C	8	200	940	*12	*300	*160	➢ National road section with 3 lanes in the central part of Koror State ➢ Water leakage accident in the past ➢ Over 40 years aged AC pipes ➢ Dual pipelines for DN250 and DN300 because of pipe laying along both sides of road
					*10	*250	*780	
					8	200	940	
3	D	12	300	910	12	300	910	➢ National road section with 3 lanes in the central part of Koror State ➢ Over 40 years aged AC pipes
		8	200	910	8	200	910	
4	B	12	300	890	12	300	890	➢ National road section between the central part of Koror State and Ngerkesoaol service tank ➢ Water leakage accident in the past ➢ Over 40 years aged AC pipes
		8	200	890	8	200	890	
5	A	12	300	570	12	300	570	➢ National road section between Ngerkesoaol and Ngelmid service tank ➢ Over 40 years aged AC pipes
6	I	8	200	870	8	200	870	➢ Koror State road section in the northern part of the central part of Koror State ➢ Over 40 years aged AC pipes
7	J	8	200	700	8	200	700	➢ Koror State road section to T-dock with heavy traffic ➢ Water leakage accident in the past ➢ Over 40 years aged AC pipes
8	G	8	200	1,500	8	200	1,500	➢ Koror State road section in the southern part of the central part of Koror State ➢ Over 40 years aged AC pipes
9	H	8	200	2,830	8	200	2,830	➢ Koror State road section in the hill of Koror State (Ngerbeched) ➢ Low water pressure area ➢ Over 40 years aged AC pipes
Total				12,920			12,920	*Showing road length and excluding the length of the 2nd pipeline

Notes: Total road length is 12,920m for pipelines. Since dual pipelines are proposed in the Route C, total length for replacement is 13,860m.
Source: JICA Survey Team

Improvement of low service pressure areas is expected to be realized by re-arrangement of water distribution zones, and increase of dynamic water pressure is anticipated in the areas. On the other hand, it is possible that this increase of dynamic water pressure causes the water leakage from the remained water distribution pipes (AC pipes). Therefore, after the Project, monitoring is necessity for the unimproved AC pipes and lateral pipes. In particular, it is important to monitor low altitude areas (high water pressure areas) along the coast.



Notes: The legend for pipe type refers to existing pipes. Heavy lines represent proposed distribution pipelines. The color coding of pipe types in the legend is independent from the color coding of priorities in bold letters.

Source: JICA Survey Team

Figure 2-2-38 Map of High Priority Aged-Pipelines for Replacement

(2) Pipe Types, Diameters, Installation Methods, and Standard Cross-sections

1) Pipe Types of Water Distribution Pipelines

In the Project, the pipelines of 8in to 12in (200mm to 300mm) diameter are replaced. For the water distribution pipelines to be laid under roads, the common pipe types are PVC pipes, DCIPs and HDPE pipes. Based on comparison of the above three (3) types for material in workability, maintainability and cost efficiency, the PVC pipes are proposed for the Project.

Moreover, the PVC pipes are presently utilized by PPUC for distribution pipelines and also requested by PPUC for the Project because of easy handling in the O&M stage.

2) Method of Installation

The open-cut method is selected for the pipe laying works of the water distribution pipelines, considering workability and cost efficiency. The open-cut method is appropriate because the excavation depth is shallow at approximately 44.8in to 52.7in (112cm to 132cm) and the lateral pipe branching work is necessary in the Project and in the future.

3) Location of Pipelines

The national roads in the central part of Koror State are managed by BPW. The state roads are separately managed by the Koror State Government.

Based on the instruction of BPW, the proposed water distribution pipelines should be basically laid along the opposite side of sewers. 12in (300mm) is secured as the minimum clearance from the existing pipes (water pipelines, sewers, etc.)

Table 2-2-36 Comparison of Distribution Pipe Types

Pipe type	DCIP (Ductile cast iron pipe)	PVC (Polyvinyl Chloride)	HDPE (high-density polyethylene)
Outline	Less attention is required for installation, because of high strength, stiffness, and shock resistance. The weight is more disadvantageous than other pipe materials, especially for easiness of transportation and installation.	Frequently adopted in small-diameter pipelines. Good in corrosion resistance. Easier to manufacture special shape pipes. Easier for installation at lower cost. The pipe is more flexible than ductile pipes, because of lower rigidity.	Frequently adopted in small-diameter pipelines. Good in corrosion resistance. Higher flexibility. EF-type joint (See next cell below) is adopted. The pipe is more flexible than ductile pipes, because of lower rigidity.
Joint structure	T type, push-on joint.	In Palau, rubber ring connection is used. Detachment prevention fittings are available to prevent detachment at bends and curves.	EF-type joint welded by heating wire.
Bend	To use various bent pipes.	To use various bent pipes.	To use various bent pipes.
Inner coating	Inner mortar coating, epoxy resin coating, etc.	No special coating necessary.	No special coating necessary.
Applicable diameter	2in to 104in (50mm to 2,600mm)	2in to 24in (50mm to 600mm)	2in to 16in (50mm to 400mm)
Workability and maintainability	Higher adjustability in bending angle at connecting point. Lower workability than PVC and HDPE since the pipe is stiff. Possible to work in rainy days.	Possible for rapid work, because of light weight. Various types of bend pipes are available. Possible to work in rainy days. PPUC requests to utilize PVC, because of workability, easy repair and easy maintenance.	Since light weight, quick transport and installation are possible. Longer construction period due to EF-type joint. Various bends are available. Since EF-joint, difficult to work in rainy days.
	C	A	C
Physical performance	High stiffness.	Low stiffness. Weak for concentrated loads. Backfilling with sand is necessary to protect the pipe.	Low stiffness, but high resiliency. Weak for concentrated loads. Backfilling with sand is necessary to protect the pipe.
	A	C	B
Corrosion resistance	Lower than PVC and HDPE. Polyethylene sleeves necessary against corrosive soils.	Higher resistance to acid, alkali, electricity, etc. Weak for organic solvent. To be deteriorated by ultraviolet ray (no problem in case to be laid underground). To be deteriorated by petroleum (no problem in general for the case of drinking water purpose).	Higher resistance to alkali, electricity, etc. To be deteriorated by ultraviolet ray (no problem in case to be laid underground). To be deteriorated by petroleum (no problem in general for the case of drinking water purpose).
	B	A	A
Cost efficiency	Pipe material: DCIP (T type) Expensive	Pipe material: PVC Inexpensive	Pipe material: HDPE Less expensive than DCIP, but more expensive than PVC.
	C	A	C
Overall evaluation	Enough records for experience are available. Good workability, but more expensive than other pipe materials.	Enough records for experience are available. Flexible in workability. Least expensive among the three (3) kinds of material. Requested by PPUC to be adopted in the Project.	Less records of experience than DCIP and PVC. More expensive and less workability than PVC.
	C	A	B

Notes: Advantage Rank: A-High, B-Moderate, C-Low.
Source: JICA Survey Team

4) Cross Section of Typical Excavation

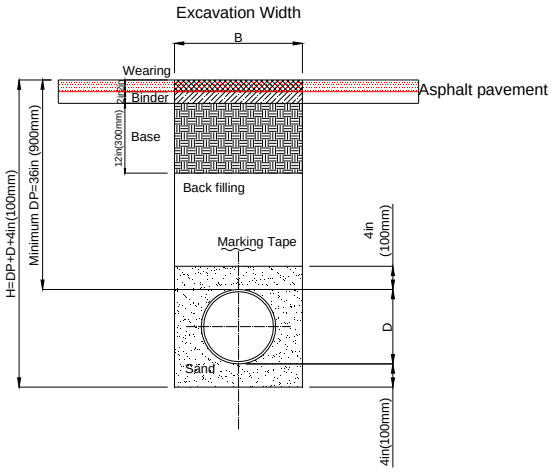
- National roads are managed by BPW. There are no future plans for the overlaying, etc. No regulation is available on a prohibited period for excavation after the pavement. There is also no information for standard drawings or specifications for pipe laying. The proposed pipelines are, therefore, installed according to the specifications for the existing water distribution pipelines.
- Based on the instruction of BPW, the minimum earth cover of the proposed water distribution pipelines is to be 36in (900mm).
- The open-cut method is proposed since the depth of excavation is less than 60in (150cm) for distribution pipelines.
- It is necessary to backfill the trenches with sand for 4in (100mm) thickness at both under and above the pipe to avoid external pressure.

a) Roads Managed by Koror State Government

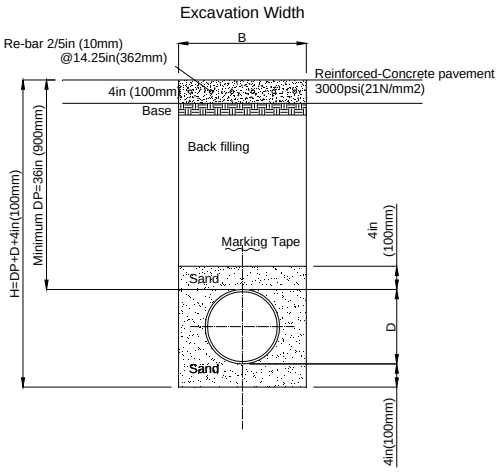
- For roads managed by Koror State Government, there is also no information for standard drawings or specifications. Based on the instruction of Koror State Government, the earth cover or other specifications are planned to be same as the national roads.
- The minimum earth cover is 36in (900mm).
- The open-cut method is proposed for the pipe laying work.
- It is necessary to backfill the trenches with sand for 4in (100mm) thickness at both under and above the pipe to avoid external pressure.

Figure 2-2-39 and Figure 2-2-40 show the typical cross sections of excavation for the proposed water distribution pipelines by type of the exiting pavement, such as asphalt pavement, concrete pavement and gravel pavement.

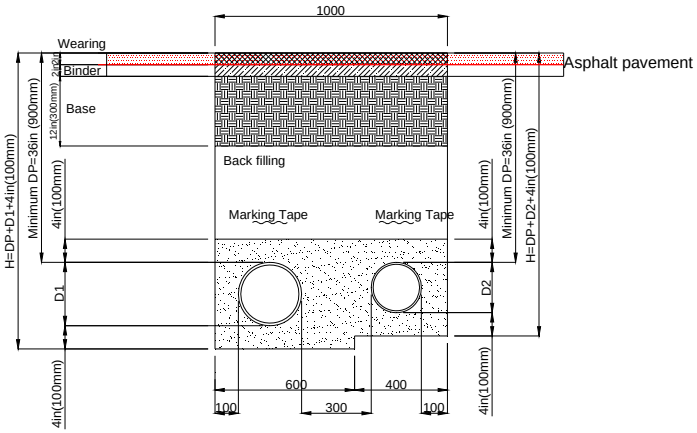
Type1: Asphalt pavement



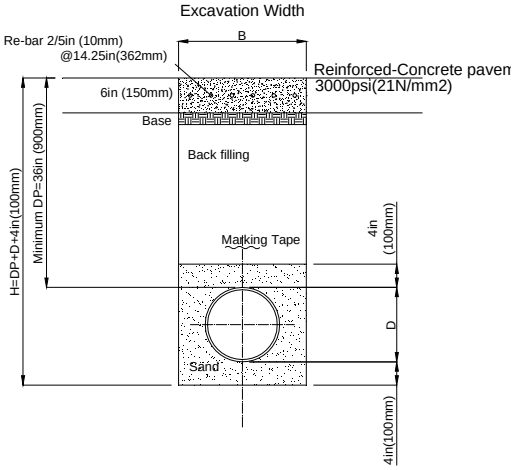
Type2-1: Reinforced-Concrete pavement



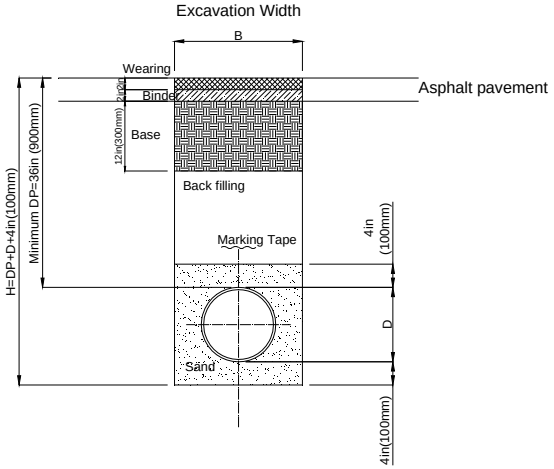
Type1-1: Asphalt pavement
Distribution x Transmission



Type2-2: Reinforced-Concrete pavement



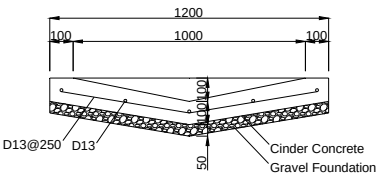
Type1-2: Asphalt pavement



EXCAVATION WIDTH

Nominal Dia (mm)	W (mm)
50～250	500
300	550

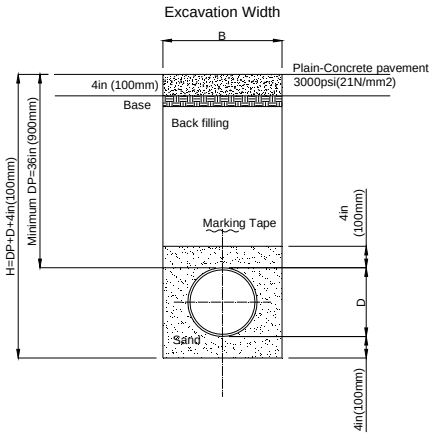
Type C: V-ditch



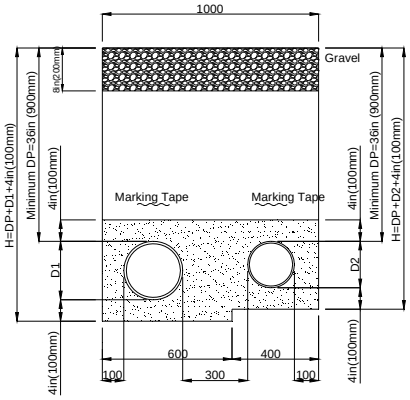
Source: JICA Survey Team

Figure 2-2-39 Typical Cross Section of Excavation for Water Distribution Pipelines (1)

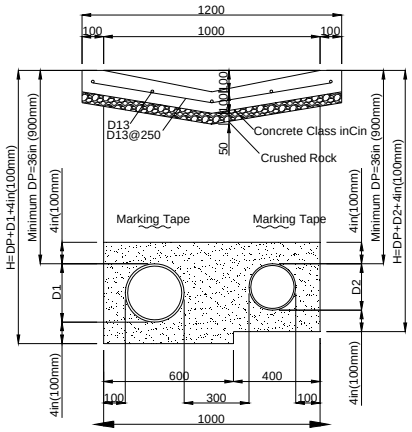
Type3: Plain-Concrete pavement



Type4: Gravel
Distribution x Transmission



Type C-1:V-ditch

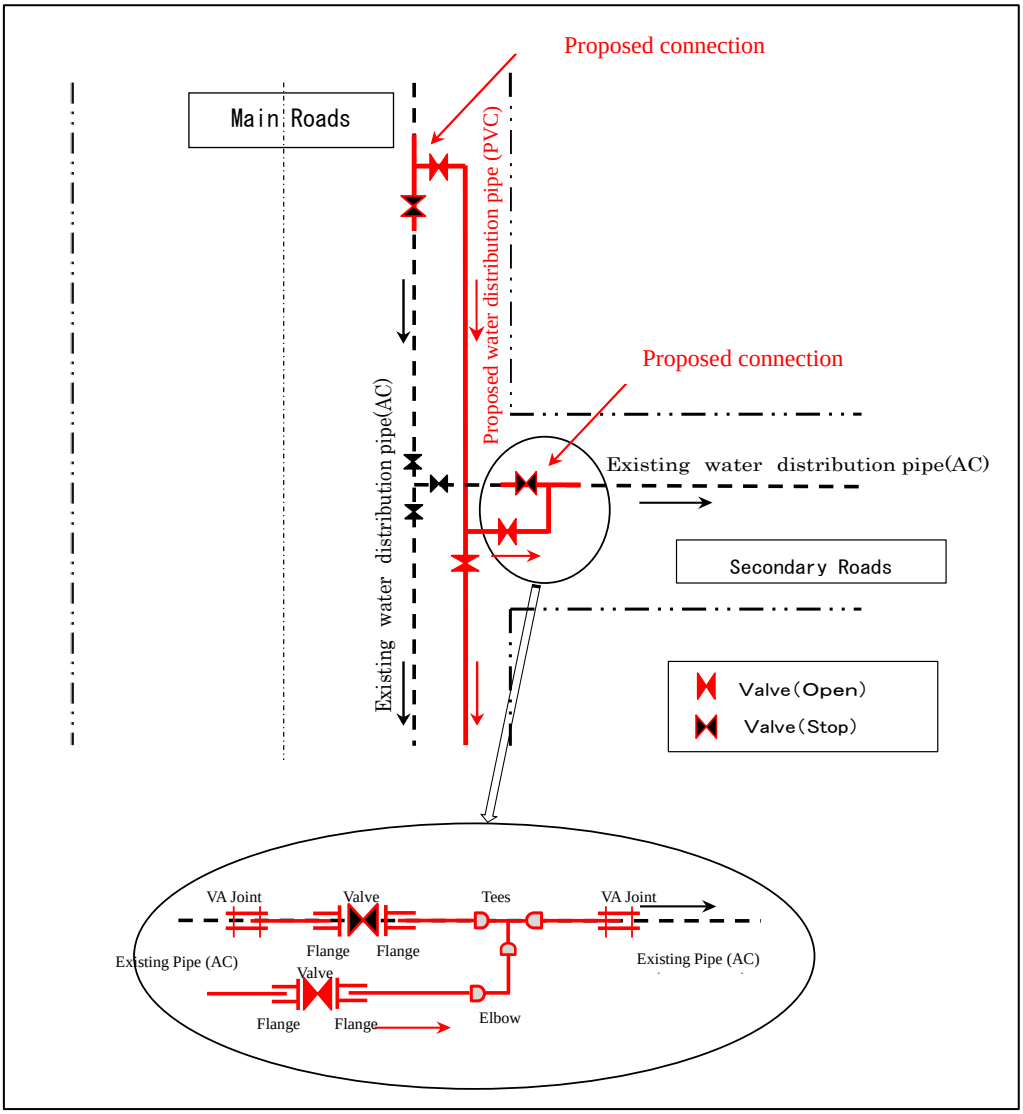


Source: JICA Survey Team

Figure 2-2-40 Typical Cross Section of Excavation for Water Distribution Pipelines (2)

5) Connection to Existing Water Distribution Branch

Figure 2-2-41 shows the typical connection to the existing water distribution pipes. Sluice valves are installed at the branches in order to switch over the connection easily form the existing pipeline to the proposed one.



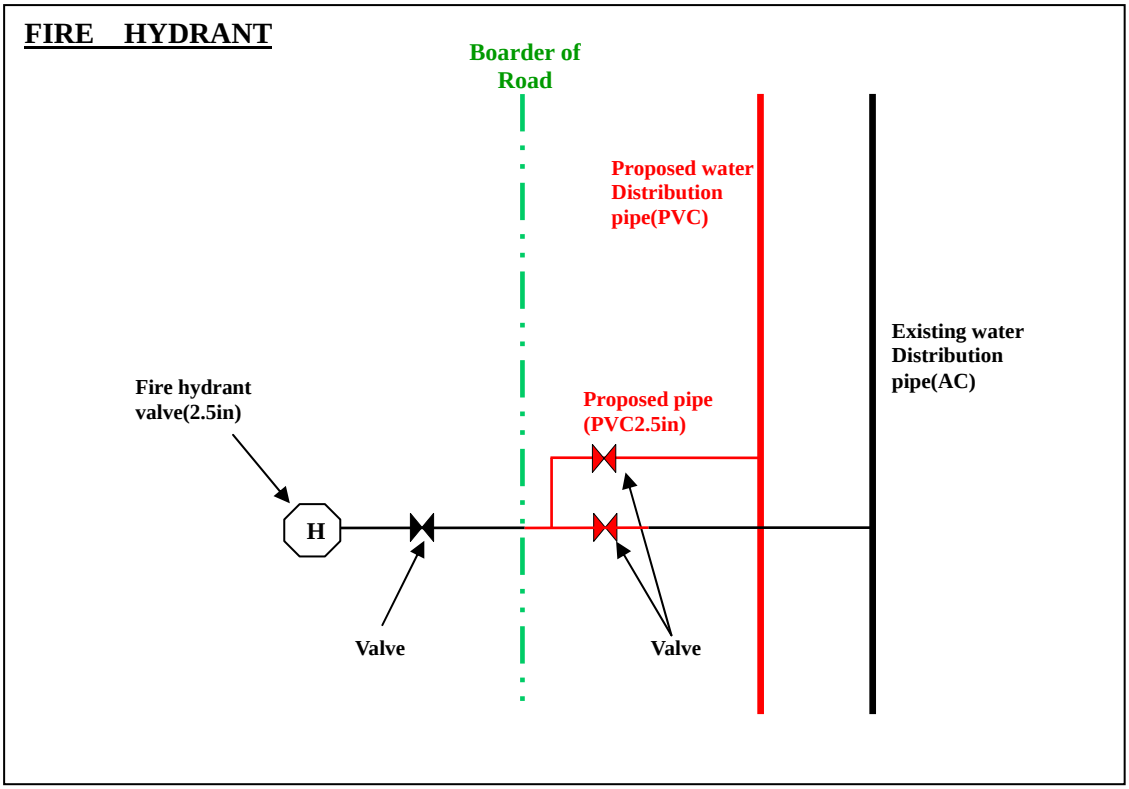
Source: JICA Survey Team

Figure 2-2-41 Typical Connection to Existing Water Distribution Pipes

6) Fire Hydrants and Air Valves

At present, existing fire hydrants are installed outside of public road. Accordingly, the fire hydrants are not replaced in the Project. The Project provides necessary pipe connections to the existing feeders for the fire hydrants under the public road.

Air valves are installed at higher altitude points than surrounding area, based on the result of topographic survey.



Source: JICA Survey Team

Figure 2-2-42 Connection to Fire Hydrants

(3) Restoration of Pavement

In the Project, there are four (4) types of pavement in the routes of water distribution pipelines, such as asphalt, reinforced concrete, plain concrete and gravel. The cross sections are shown in Figure 2-2-39 and Figure 2-2-40. In principle, the pavement should be restored to its original condition as described below:

a) Asphalt Pavement

Most of the national roads and some state roads managed are paved with asphalt. To install water distribution pipes and lateral pipes, the pavement will be cut in a ladder shape. The top surfaces (2in (5cm) in thickness) of the pavement, therefore, are scraped for the entire road width and paved with overlaying asphalt, after the installation of the pipelines.

There are no lateral pipes for approximately 220m at the southern edge of Malakal Island. Accordingly, the overlaying width in the re-pavement is for half width of road, which is excavated for the pipelines.

In the southern part of Ngerbeched area, excluding the road to be improved with concreate pavement by 2015, the re-pavement is provided just for excavation width since the current pavement is deteriorated.

Road signs indicating lanes and shoulders, which are embedded in the pavement of the national roads, will be removed when the top layer is cut out. These road signs are restored with white marking lines according to the instruction by BPW.

Since some roads are presently under re-pavement procedures, the conditions and progresses should be confirmed at the detail design stage.

b) Reinforced Concrete Pavement

Only the excavation part will be restored with equivalent material to the original one.

c) Plain Pavement

Only the excavation part will be restored with equivalent material to the original one.

d) Gravel

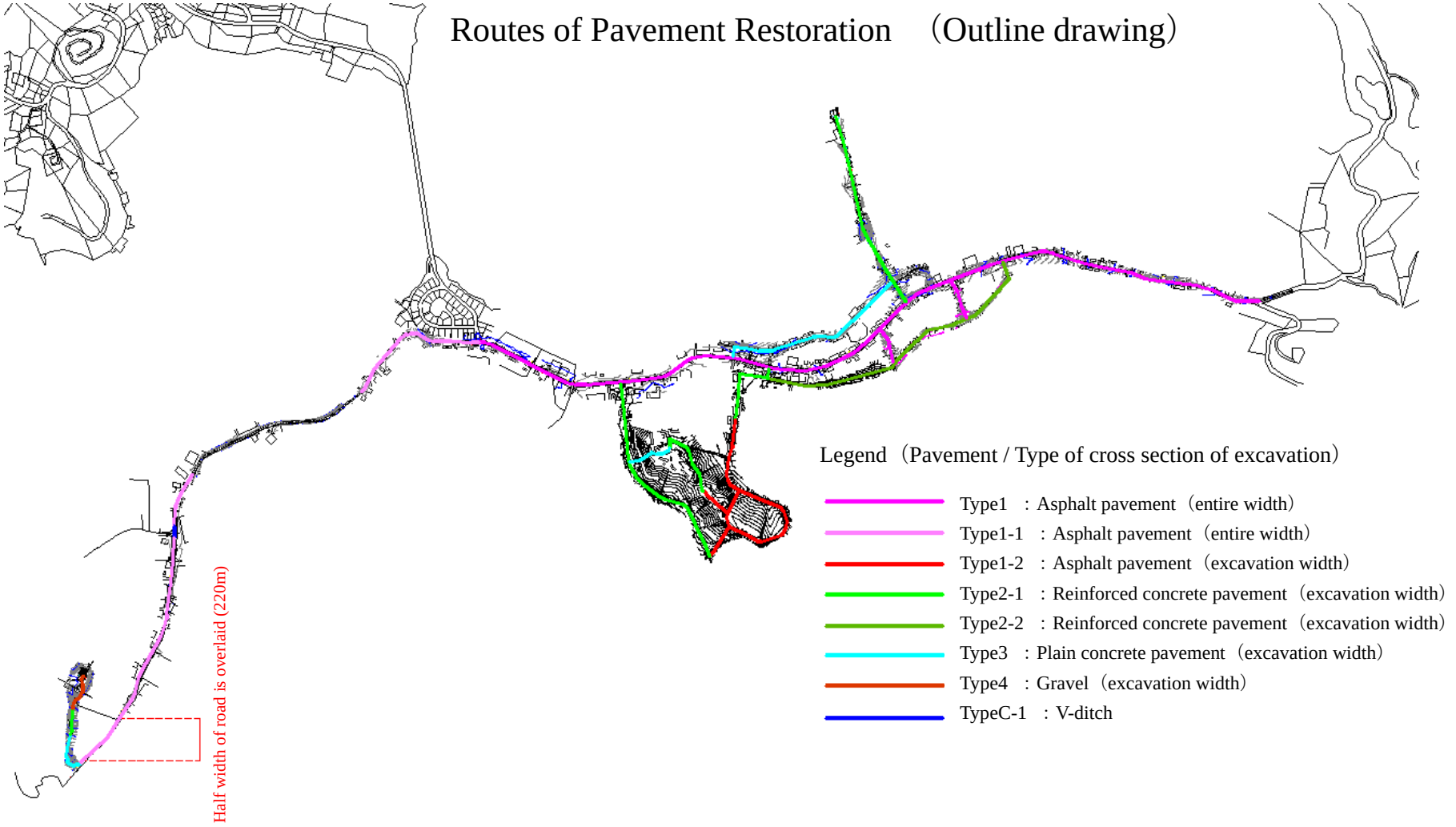
Only the access road to Malakal service tank, which PPUC plans to provide before construction of the tank, is paved by compacted gravel. During the construction period, the road should be maintained by the Contractor to repair damages caused by construction vehicles, storms, etc. After the pipe laying works, the road surface will be restored to the original condition.

As results of the above examinations, the pavement restoration is summarized in Table 2-2-37. Figure 2-2-43 shows routes by restoration method.

Table 2-2-37 Restoration of Pavement for Water Transmission/Distribution Pipes

Installation	Road Type	Current Condition	Restoration of Pavement
Water transmission pipes (single installation)	National road	Asphalt pavement	Restoration of excavation width +40cm (margin width for both sides)
Water transmission/distribution pipes (double installation)	National road	Asphalt pavement	After provisional restoration of excavation width, entire width of road is overlaid
Water transmission/distribution pipes (double installation)	National road	Asphalt pavement (southern edge of Malakal Island)	After provisional restoration of excavation width, half width of road is overlaid
Water transmission/distribution pipes (double installation)	State road	Reinforced concrete pavement (access road to Malakal service tank)	Restoration of excavation width
Water transmission/distribution pipes (double installation)	State road	Gravel (access road to Malakal service tank)	During construction, the Contractor restores the road to the original condition.
Water distribution pipes (single installation)	National/State road	Asphalt pavement	After provisional restoration of excavation width, entire width of road is overlaid
Water distribution pipes (single installation)	State road	Reinforced/Plain concrete pavement	Restoration of excavation width
Water distribution pipes (single installation)	State road	Asphalt pavement (southern part of Ngerbeched area)	Restoration of excavation width

Source: JICA Survey Team



Source: JICA Survey Team

Figure 2-2-43 Routes of Pavement Restoration

(4) Lateral Pipes

1) Type of Lateral Pipe and Minimum Earth Covering

PVC (AWWA SCH80), which is same as the existing lateral pipe, is selected for the material to be applied in the Project. It. The diameter of lateral pipe is 2in (50mm). The minimum earth cover is 12in (300mm).

2) Scope of Works for Lateral Pipe and Connecting Method

Figure 2-2-44 shows the conceptual drawing of lateral connection. Work procedure and scope of works are described below:

a) Lateral connection : The scope of works by the Japanese side

The lateral pipe should be branched off from the proposed distribution pipeline. The lateral pipe should be laid by the Japanese side to the border of road and be ended with valves.

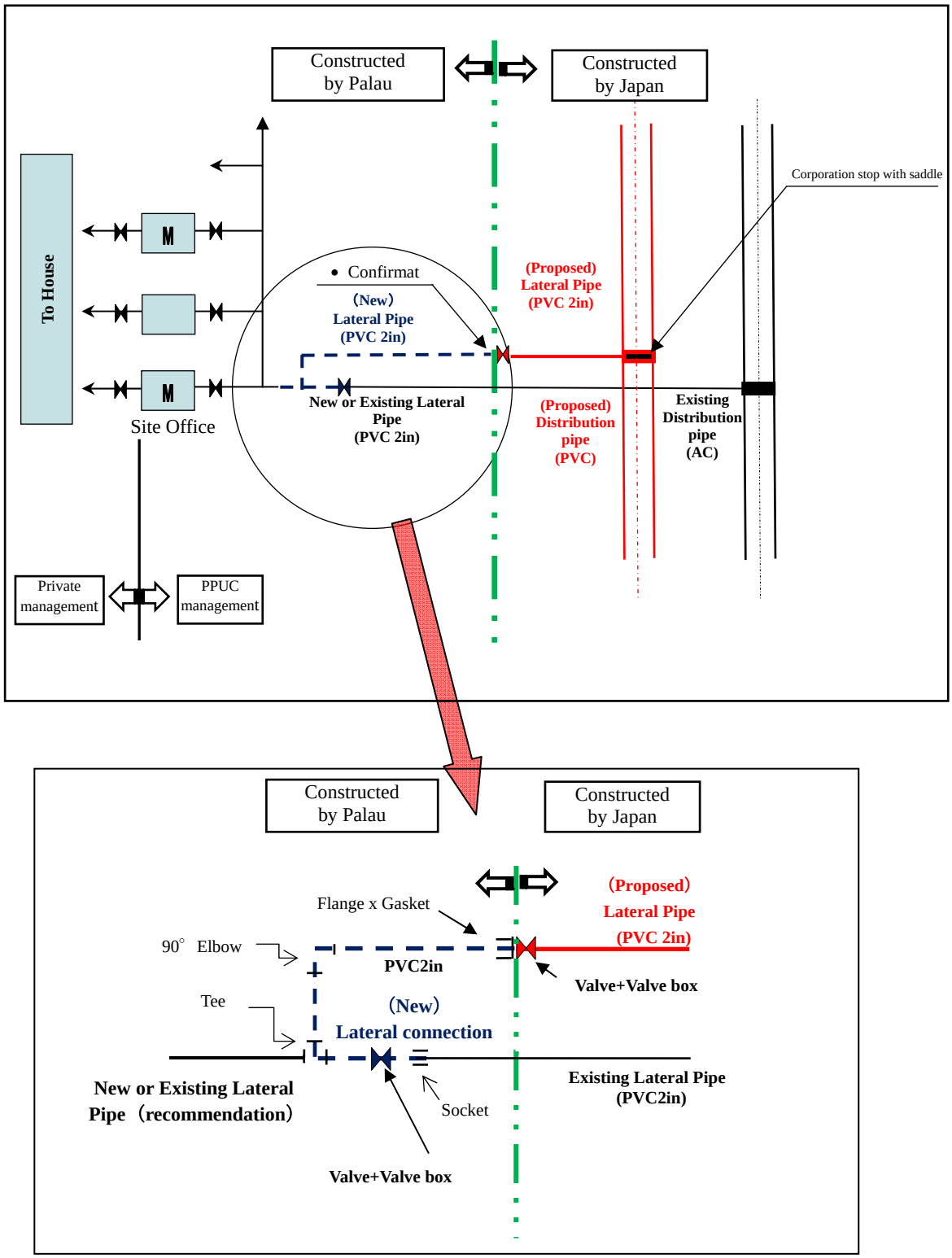
b) Lateral connection : The scope of works by the Palauan side

The branched lateral pipe by the Japanese side should be connected by PPUC to the existing one or newly installed one in the private premise / outside of road.

PPUC shall assign staff members, who will fully attend the pipe laying works of the Japanese side, to find out location of the existing lateral pipes.

c) Replacement of existing lateral pipes : Recommendation for PPUC

It is emphasized that most of the existing lateral pipes should be replaced by PPUC, since the existing lateral pipes are aged, deteriorated and one of causes of leakage.

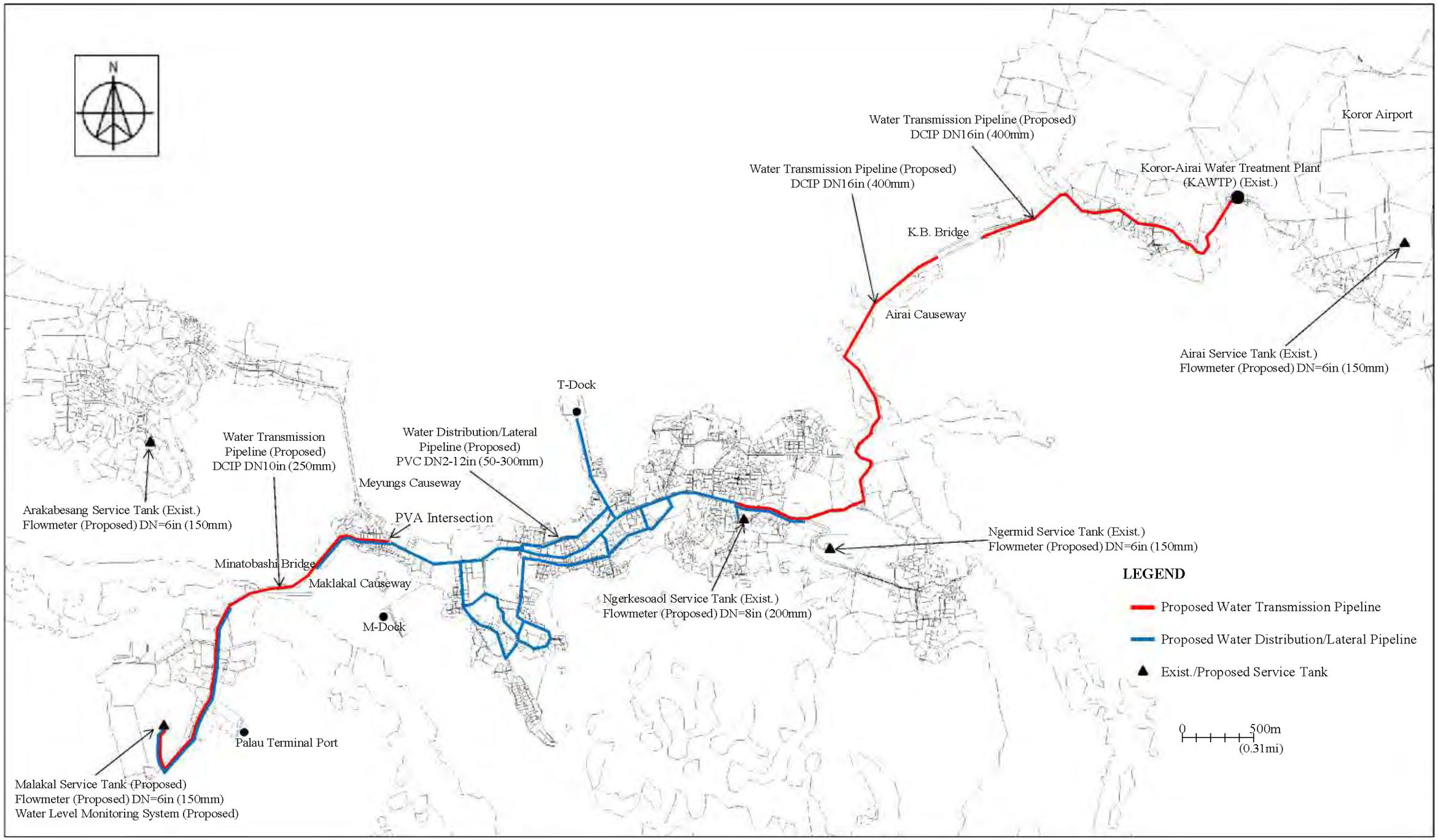


Source: JICA Survey Team

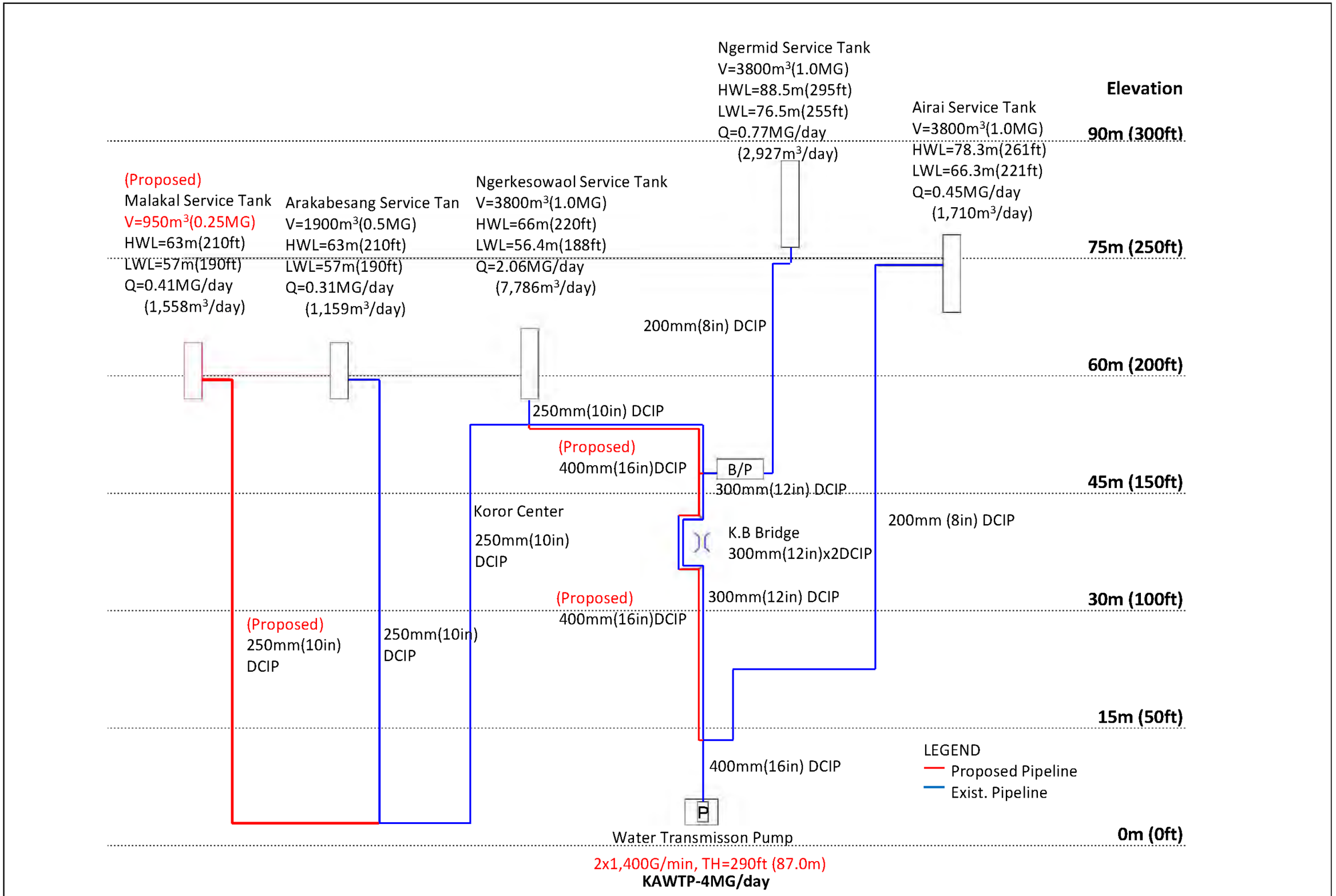
Figure 2-2-44 Conceptual Drawing of Lateral Connection

2-2-3 Outline Design Drawings

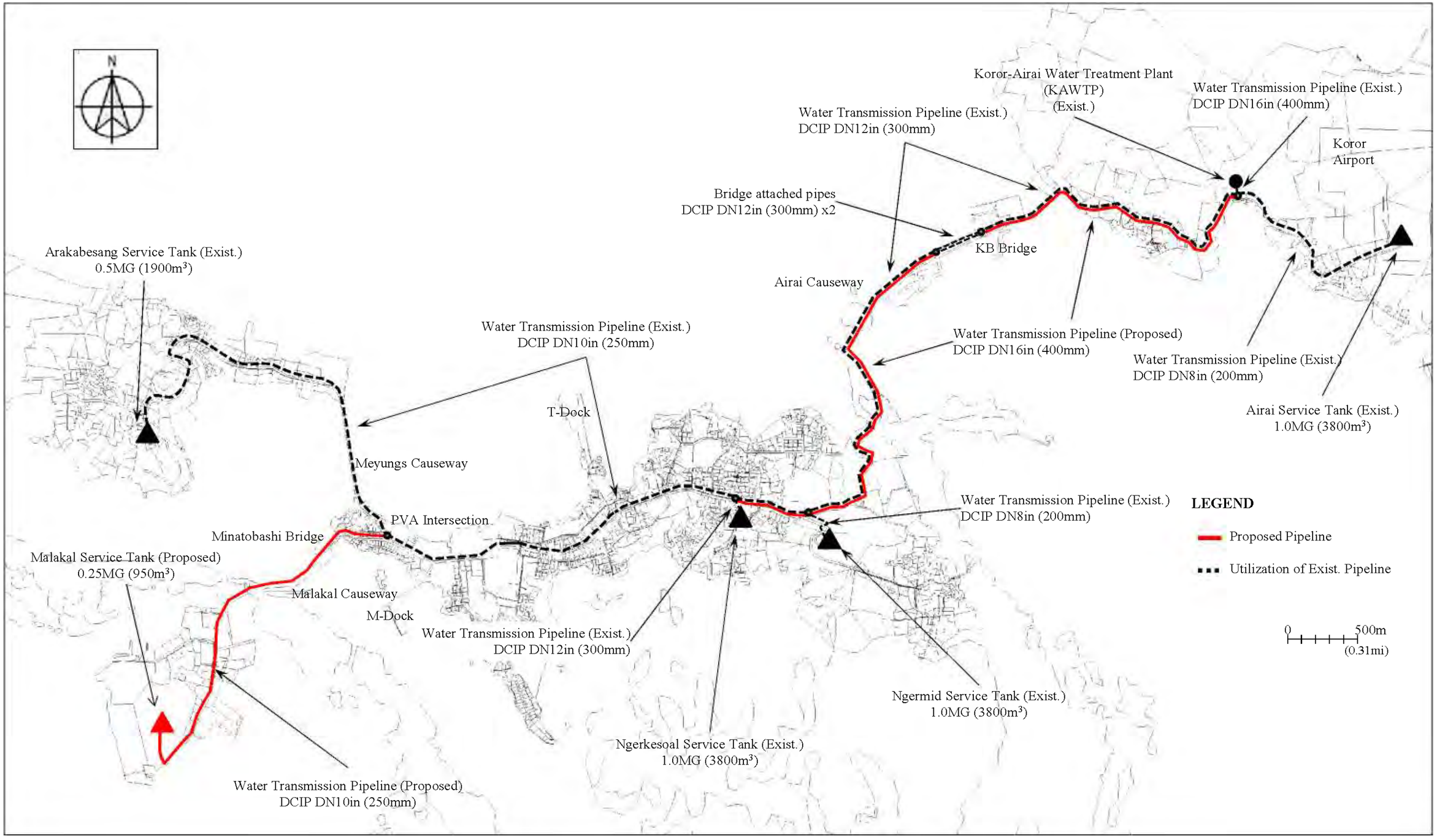
DWG No.	Title
PWS-01:	General Layout Plan
PWS-02:	Water Transmission System Flow
PWS-03:	Layout Plan of Water Transmission Main
PWS-04:	Layout Plan of Water Distribution Pipeline
PWS-05:	Layout Plan of Malakal Service Tank
PWS-06:	Structural Drawing of Malakal Service Tank



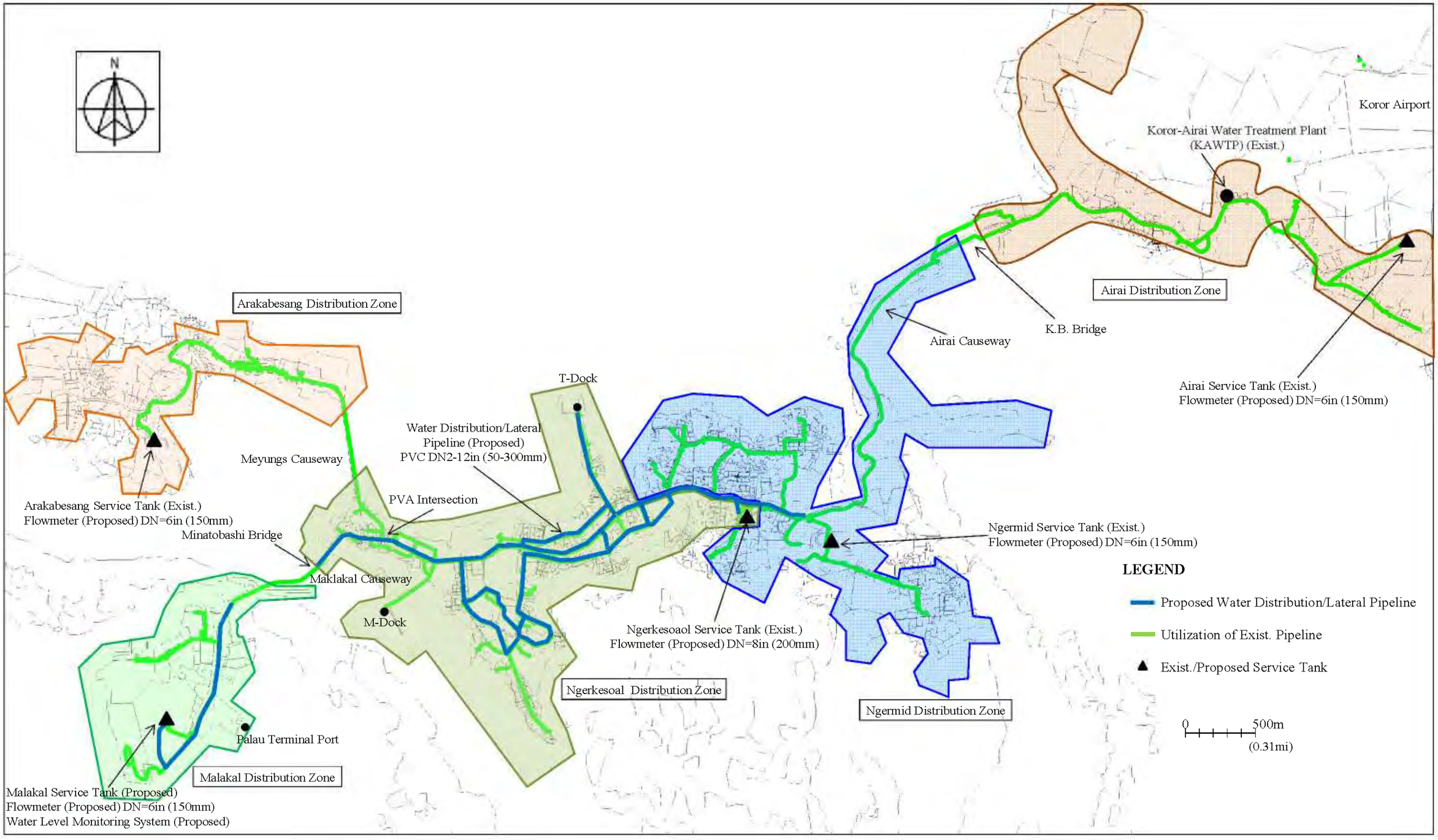
PWS-01 General Layout Plan



PWS-02 Water Transmission System Flow



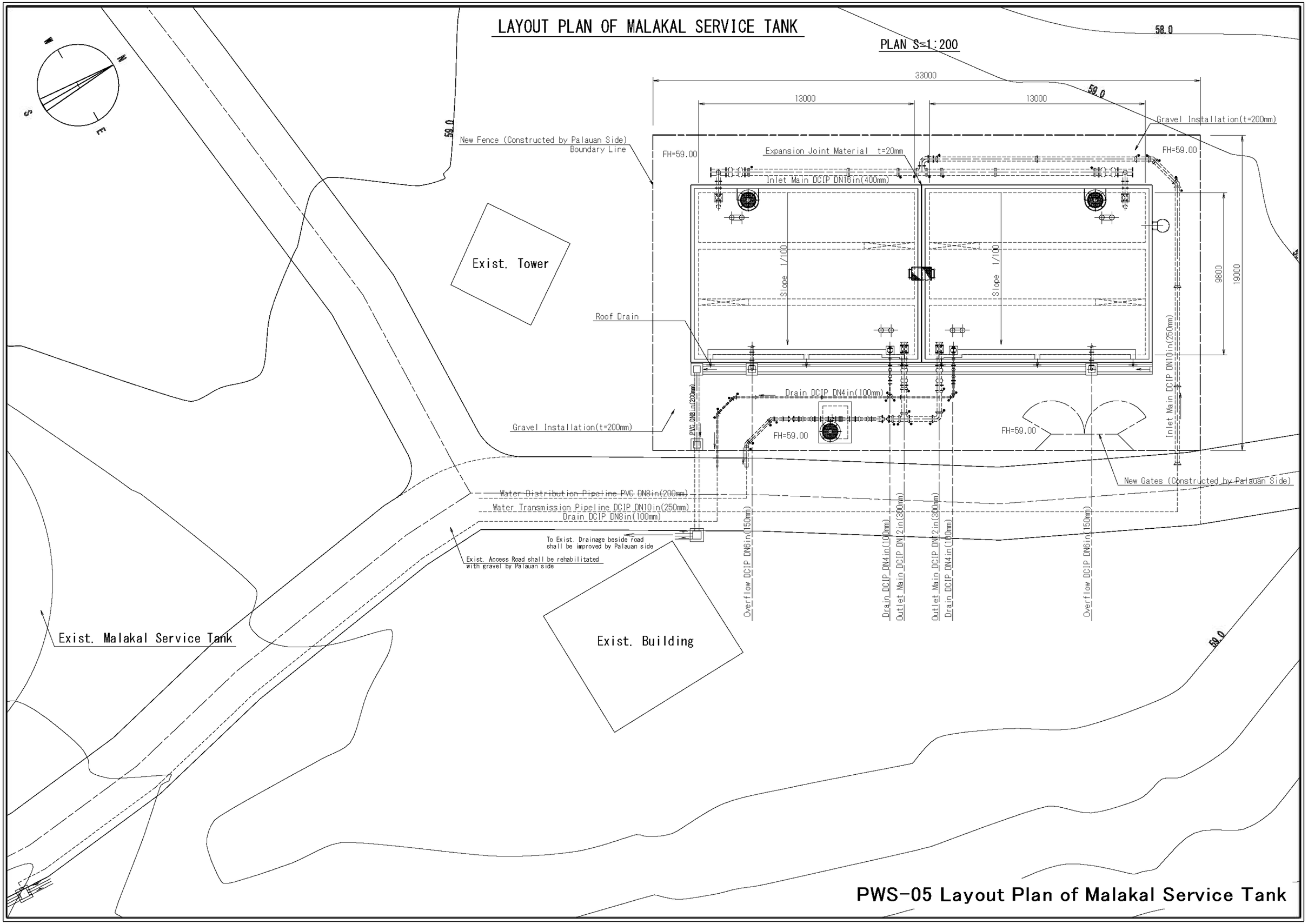
PWS-03 Layout Plan of Water Transmission Main



PWS-04 Layout Plan of Water Distribution Pipeline

LAYOUT PLAN OF MALAKAL SERVICE TANK

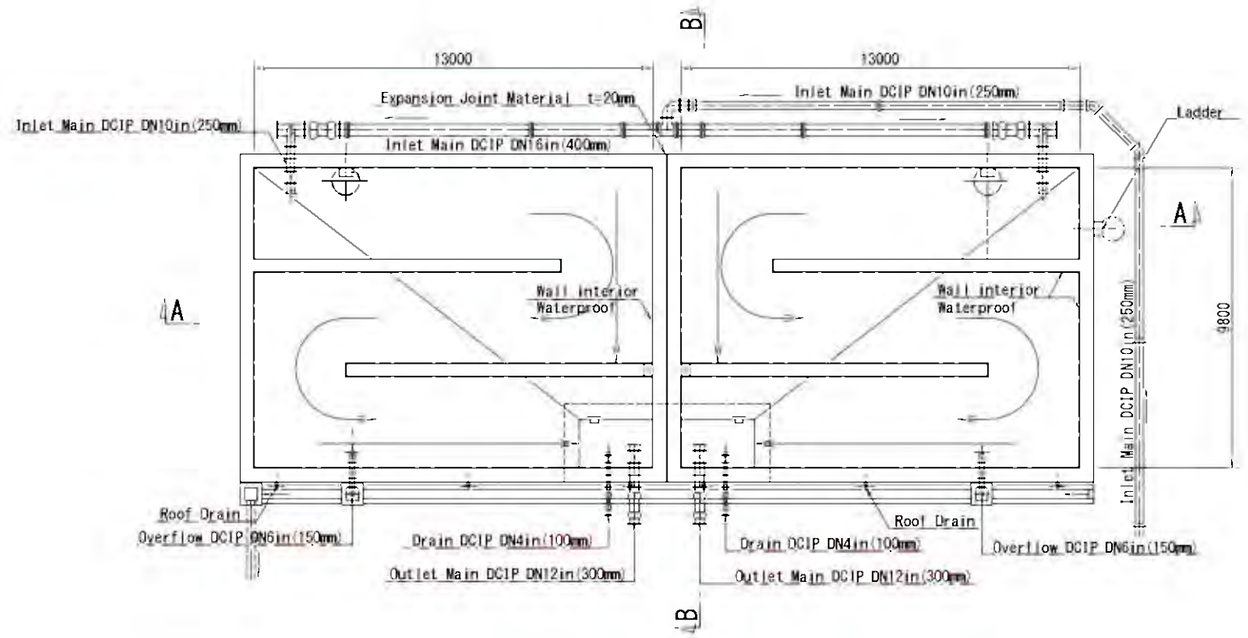
PLAN S=1:200



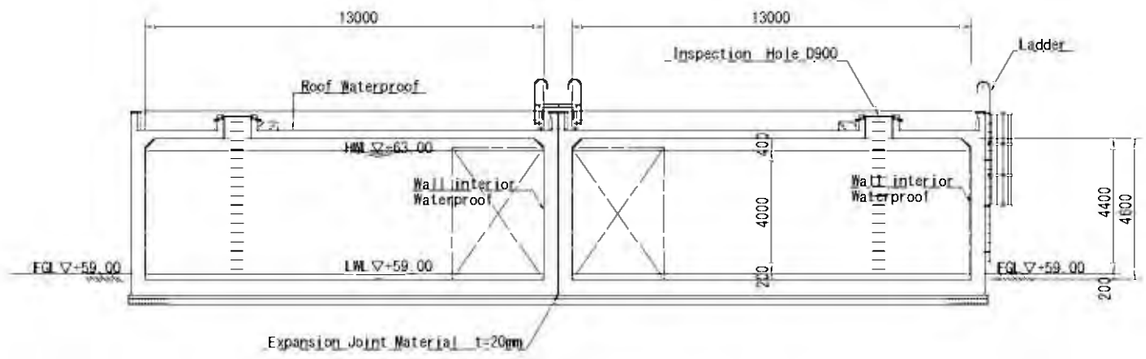
PWS-05 Layout Plan of Malakal Service Tank

STRUCTURAL DRAWING OF MALAKAL SERVICE TANK

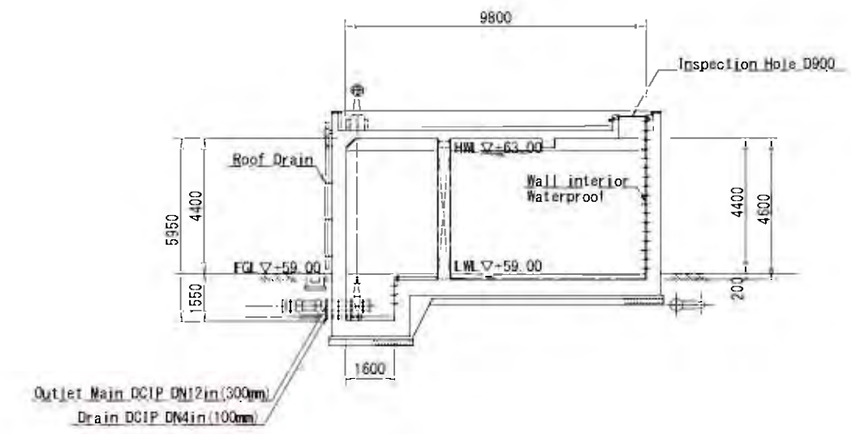
PLAN S=1:200



A-A SECTION S=1:200



B-B SECTION S=1:200



PWS-06 Structural Drawing of Malakal Service Tank

2-2-4 Implementation and Procurement Plan

2-2-4-1 Implementation and Procurement Policy

The Project is implemented according to the framework of Japan's Grant Aid. Therefore, after the conclusion of E/N between the two (2) governments, the Palauan side enters into a contract with Japanese companies for detailed design, work execution, and/or procurement of materials and equipment.

Considering the framework of Japan's Grant Aid and the nature of construction works, the implementation plan shall be formulated according to the following basic concept.

(1) Implementing Agency

On the Palauan side, PPUC is the implementing agency. PPUC needs to accomplish the Project, and to operate and maintain the facilities after the completion of construction. Furthermore, for the purpose of smooth project implementation, PPUC needs to assign a person responsible for the Project, who communicates and discuss with the Consultant and/or the Contractor.

The person in charge of the Project is responsible to explain construction contents in detail for the stakeholders related to the Project, such as staff members of PPUC, and residents of areas near the Project site.

[Role of PPUC in the Project]

- Confirmation, coordination, and arrangement of the scope of works for the Palauan and Japanese sides.
- Provision of technical information necessary for facility design and other activities.
- O&M of water supply facilities and provision of technical information relating to management of water supply services.
- O&M of facilities and equipment constructed / installed in the Project.

(2) The Consultant

The Project is implemented under the Japan's Grant Aid scheme. Therefore, it is necessary to select a Japanese contractor by competitive tender, after preparing tender documents necessary for the selection of the Contractor. In addition, it is necessary to conduct appropriate competitive tendering, supervision of work execution and procurement of materials and equipment, and monitoring on appropriate use of the Grant Aid fund.

Therefore, PPUC, as the implementing agency on the Palauan side needs to enter into an agreement for design and supervision with a Japanese consultant firm and entrust design and supervision to it. It is necessary for the Consultant to "be familiar with the mechanism of the Japan's Grant Aid" and "have sufficient understandings on the content of this outline design"

(3) The Contractor for the Facility Construction

The Contractor is selected by tendering in accordance with the framework of Japan's Grant Aid system. The Palauan side, with the Consultant to perform design and supervision, needs to conduct a fair competitive tendering and select the Contractor. The Contractor is required to satisfy the following:

- Since the facility construction works are performed in remote areas where social, cultural and historical environment and background differ from those in Japan, the Contractor shall be a firm that has sufficient experience and good track records in similar works and countries.
- The Contractor shall have the ability to construct similar facilities, which are water transmission and water distribution pipelines and water tanks.

(4) Needs for Dispatching Engineers

While skilled workers is not able to be procured easily in Palau, it is necessary to conduct works under the guidance of skilled and specialized technicians for piping work and concreate tank, because of the reasons described below. Therefore, specialized and skilled technicians engaging in piping, formwork and waterproofing need to be dispatched from Japan or the third countries.

- Piping work of DCIP has not been carried out for more than 20 years. It is necessary to be supervised by skilled technicians engaging piping work at the initial stage of construction of water transmission main.
- Although small-scale piping work of PVC pipeline has been carried out, a large-scale piping work, such as improvement of whole networks in urban areas, has not been carried out for over 40 years. As well as piping work of water transmission main, it is necessary to be supervised by skilled technicians engaging piping work for water distribution pipelines.
- The construction of RC-made structure, such as the service tank, requires water tightness. Since there are few cases of RC-made service tank in Palau, it is necessary to dispatch skilled technicians engaging formwork and waterproof in order to supervise workers.

2-2-4-2 Implementation Conditions

Points of attention in the formulation of execution plans are as follows:.

(1) Facility Construction

- During construction of water transmission main and distribution pipelines, it is necessary to restrain the turbid water, which may flow into nearby streams and affect the water quality.
- In construction work plan, it is necessary to pay attentions for protection of the existing underground facilities such as aged water distribution pipelines.
- In all construction sites, traffic guards and security personnel must be stationed to ensure safety management for the third parties and theft prevention. Safety countermeasures by the Palauan side are also mandatory. For a storage site of construction materials, the Japanese side also needs to arrange security guards and fences as countermeasures.
- For the replacement of the existing AC pipelines, MPIIC and EQPB do not allow the removal and disposal of AC pipes. In the Project, the abandoned AC pipes are left in the underground as they are. When the pipelines are replaced, AC pipes are cut for some certain length, even in that case, the cut out pipelines are buried inside of the excavated trench. In addition, when cuts of the existing AC pipes are needed, the pipeline is not to be “cut”, but to be pulled-out from the sockets.
- In the above case, to avoid the scattering of asbestos dust, the pulling-out work should be conducted in wet conditions after watering in procedures. Furthermore, precautions should be explained to workers before construction, such as the harmful effect of asbestos to human health, handling way, prevention method for scattering and protection items.

(2) Procurement of Materials and Equipment

- Materials except for aggregates, cement, concrete form, ready-mixed concrete, are difficult to be procured locally. Most of materials and equipment should be procured from Japan or the third countries.
- Local construction companies have construction machineries and transporting vehicles. The major equipment is available in Palau. Nevertheless, special equipment should be procured in Japan or the third countries.
- For the purpose of exemption of the import tax for the materials to be procured in the Project, beforehand, the Contractor needs to prepare documents for tax exemptions, together with necessary documents such as copy of bill of lading /airway bill to Bureau of Revenue, Customs

and Taxations, and Ministry of Finance through PPUC's procurement officer. At the same time, the copy should be delivered to Bureau of International Trade and Technical Assistance of Ministry of State. Through the mentioned procedures, the import tax (3%) is completely exempted, but not in refunded method. In addition, there is no consumption tax (Value Added Tax: VAT) for commodity in Palau.

- Usually, customs clearance is implemented in Malakal international seaport, which is the only international port for trading. The operation of the port is handled by a private company. Accordingly, the port charge is required as a part of sea-transportation costs.
- As for the transportation from Japan, packing should be conducted sufficiently for the enough toughness and sturdiness for the long transportation period, unloading at the port, in-land transportation to the planned site and the storage.

2-2-4-3 Scope of Work

Considering the capacity of PPUC and impact on the Project, necessary works for the facility construction, as well as the work demarcation between the Palauan and Japanese sides, are proposed in Table 2-2-38.

Table 2-2-38 Scope of Work between the Two Countries Relating to Facility Construction

Work Items	Japan	Palau
1. Improvement of water transmission system		
1-1 Additional water transmission main from KAWTP to Ngerkesoaol service tank		
－Approval for route of water transmission main		○
－Piping work for laying water transmission main DCIP, DN16in (DN400mm), L=3.39mi (5,416m)	○	
－Pavement work (overlaying and / or excavated area only)	○	
2. Improvement of water distribution system (re-arrangement of water distribution zone)		
2-1 Laying water transmission main to Malakal service tank		
－Approval for route of water transmission main		○
－Piping work for laying water distribution pipelines DCIP, DN10in (DN250mm), L=1.93mi (3,094m)	○	
－Pavement work (overlaying and / or excavated area only)	○	
2-2 Re-arrangement of water distribution zone (construction of Malakal service tank, flow meters installation)		
－Allocation of land for construction		○
－Preparation of access road to service tank		○
－Construction work for Malakal service tank , capacity: 0.25MG (950m^3), 1 unit, 2 basins, RC-made, rectangle,	○	
－Installation work of remote monitoring system of water level	○	
－Flow meter installation	○	
－Electricity supply		○
－Construction work for boundary fence / gate		○
2-3 Re-arrangement of water distribution zone (installation of flow meters to each service tank)		
－Allocation of land for construction		○
－Flow meter installation	○	
3. Improvement of water distribution system (replacement of major AC pipes)		
3-1 Replacement of aged AC pipes		
－Approval for route of water distribution pipelines		○
－Piping work for laying water distribution pipelines, PVC, DN8in (DN200mm) to DN12in (DN300mm), L=8.08mi (12,920m)	○	
－Pavement work (overlaying or excavated area only)	○	
3-2 Replacement / Lateral Connection		
－Branching lateral pipes	○	
－Switching over of lateral pipe connection		○
Temporary storage space		
－Allocation of temporary storage space		○
－Proper storage and safety management of storage space for construction materials	○	
Procedure of transportation of construction materials/ equipment, customs clearance, and Tax handling		
－Transportation to unloading port / airport	○	
－Customs clearance and the Tax exemption in Palau		○
－Transportation from unloading port to project site	○	
－Exemption or cover of inland duty such as VAT for procurement materials or equipment.		○
Obtaining all permissions for the construction from the authorities concerned		○
Bearing all the expenses, other than those to be borne by the Grant Aid		○
Provision of disposal site for surplus soil and wastewater		○
Procurement/Production of equipment and the materials	○	
Installation work of equipment, adjustment and trial operation	○	
Initial operation guidance of procured equipment, and instruction of O&M	○	

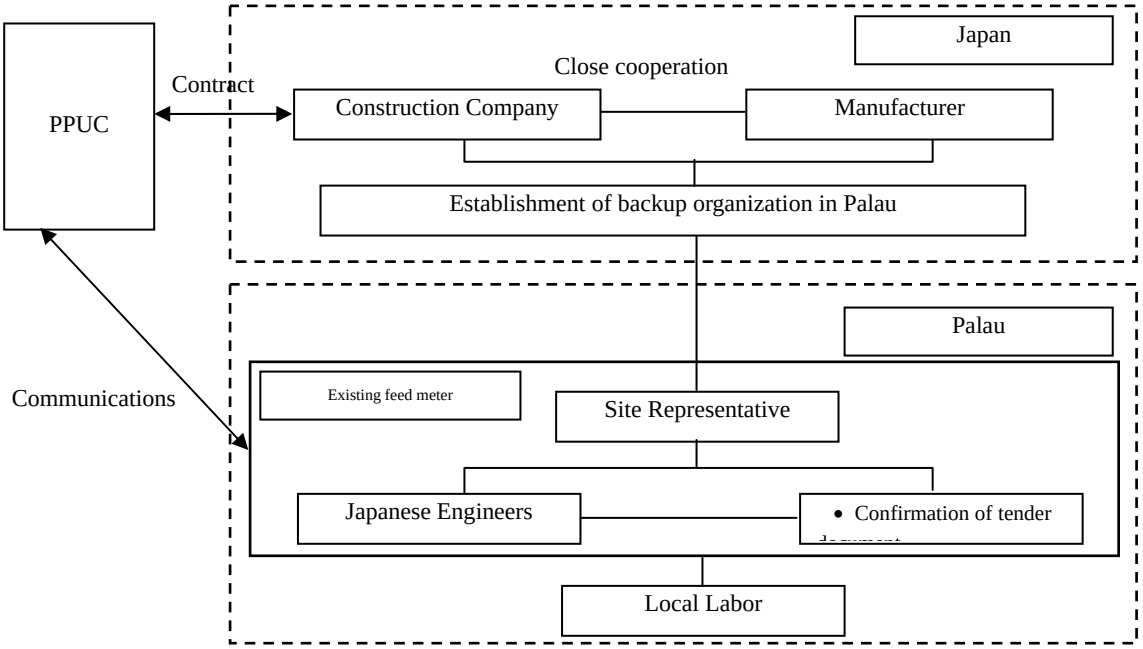
Notes: [○] shows defrayer Source: JICA Survey Team

2-2-4-4 Consultant Supervision

(1) Organization of the Contractor for Construction and Procurement

1) Implementation Organization of the Contractor

The Contractor shall establish an organization in collaboration with manufacturers of materials necessary for the water transmission and distribution facilities. Moreover, it should be considered that the Project sites are in Palau and far from Japan. The outline of the implementation organization of the Contractor should be as shown in Figure 2-2-45.



Source: JICA Survey Team

Figure 2-2-45 Implementation Organization of the Contractor

2) Backup Organization in Japan

The Contractor must establish a backup organization in Japan to provide comprehensive coordination of the all aspects of facility construction, including civil engineering work, manufacture and installation of equipment, pipe installation, etc., as well as technical and financial support to the local construction management office.

3) Local Construction Management Office

The Contractor must establish a construction management office in Palau to execute all construction works, including civil engineering and pipe installation works. They should also establish a management organization ensuring consistent and smooth execution of works in Palau. In Palau, the construction management office executes the construction works and local employment of engineers, skilled workers, operators, drivers, workers, materials and equipment suppliers.

It is not easy to locally procure specialized engineers and skilled workers, and materials and equipment needed for the facility construction. Management of progress, quality and safety should be conducted by engineers and skilled workers from Japan and/or the third countries (such as the Philippines) under the Japanese engineers having sufficient experience in facility construction for the Japan's grant aid projects.

- Since the works must be completed within the framework of the Japanese accounting system and the Japan's Grant Aid system, the management of construction progress should be conducted by engineers having full understanding on those systems.
- Since the management technology for construction work should be transferred to the Palauan

side, the construction should be conducted to incorporate the work procedures, and quality and safety management used in Japan.

4) Structure for Construction Management by the Contractor

Since the works are to be conducted in different sites simultaneously in a limited period, it is necessary to manage the construction work through the Japanese staff members as shown in Table 2-2-39.

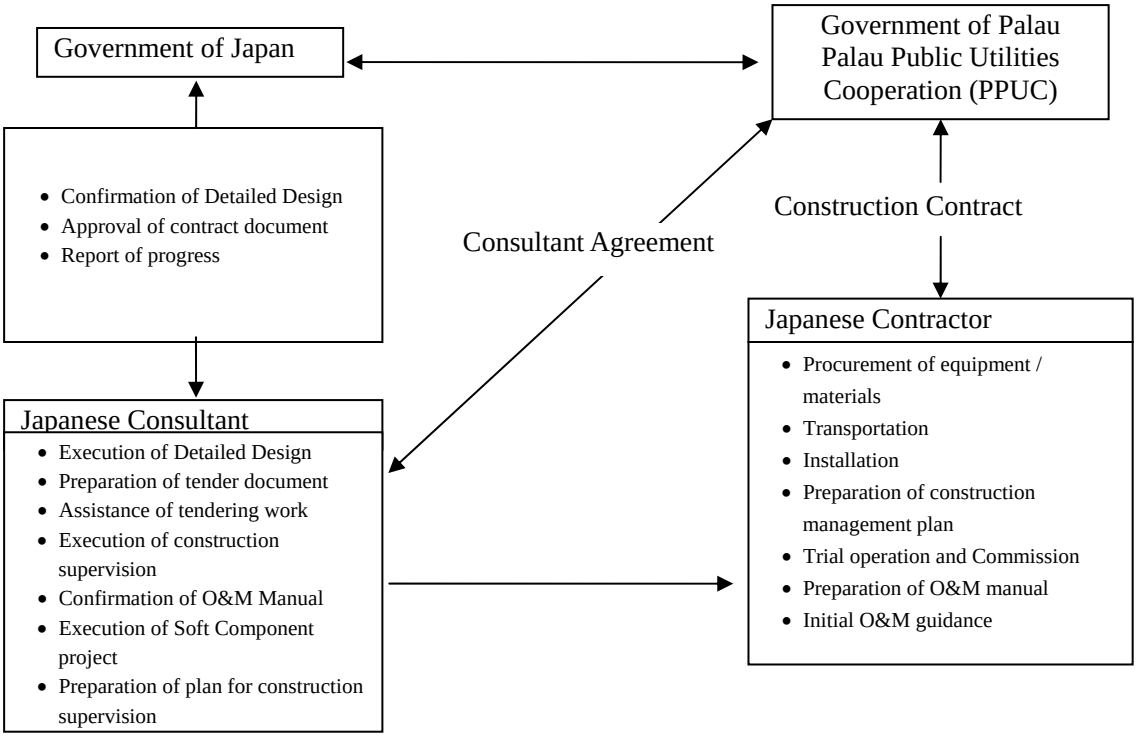
Table 2-2-39 Structure for Construction Management by the Contractor

Position	Period	Number of Persons	Work Contents
Resident Representative	Whole Period	1	- Overview of all construction works. - Discussion with the Palauan side. - Management of material procurement and construction for schedule, quality and safety for all construction works.
Chief Civil Engineer	Short period	1	- Assistant to the Resident Representative in the field of engineering and management of engineering matters. - Management of material procurement and construction for schedule, quality and safety for piping works.
Civil Engineer	Short period	1	- Management of material procurement and construction for schedule, quality and safety for construction works of service tank.
Mechanical/Electrical Device Engineer	Short period	1	- Supervising the schedule, quality and safety of mechanical and electrical works.

Source: JICA Survey Team

(2) Structure for Construction Supervision by the Consultant

The Consultant supervises and directs the Contractor for the purpose of achieving “completion of facility construction within the specified terms of construction”, “ensuring the quality of works specified in the contract documents”, and “safe execution of the works”. The Consultant shall perform the supervision of the entire Project at the position indicated in Figure 2-2-46 because a role of the Consultant is to perform independent confirmation and management of the appropriate execution of facility construction within the framework of the Japan’s Grant Aid.



Source: JICA Survey Team

Figure 2-2-46 Chart of Relations in Project Organizations

Based on the Japan's Grant Aid system, the Consultant organizes a consistent project team and performs executions of detailed design and supervision works to ensure smooth executions of the Project, based on the outline design. At the stage of construction supervision, the Consultant dispatches the following supervisors having the expertise suitable to the works for management of progress, quality and safety.

- Overall work supervisor: 1 person (stationed)
- Civil work supervisor: 1 person (spot)
- Piping work supervisor: 1person (spot)
- Mechanical/Electrical work supervisor: 1 person (spot)

In addition to the above supervisors, engineers are deployed to conduct inspections at the factories in Japan and / or the third countries as required, regarding the materials and equipment, for the purpose to prevent troubles after delivery.

(3) Basic Concept of Construction Supervision

As the basic concept of construction supervision, the Consultant supervises construction works to ensure the completion of the works within the specified terms of construction and to ensure the safe execution of works.

Points of attention in construction supervision are as follows:

1) Management of Construction Schedule

The Consultant checks the progress of works with the schedule to be submitted by the Contractor, monthly and weekly, through the following confirmation item. If a delay is foreseen, the Consultant alerts the Contractor and requests the plans of countermeasures based on examined reasons of the delay.

- Progress and the completed amount of works

- Delivery schedule for major materials and equipment
- Personnel input in the Project for engineers, skilled workers, common workers, etc.

2) Safety Management

The Consultant confirms the appropriateness of the safety management plan to be prepared by the Contractor and implementing situations the plan, in order to prevent accidents involving labors and the third parties during execution of works. Safety management shall be executed through the following means:

- Confirmation of preparation for the safety management plan and appointment of safety manager of the Contractor
- Confirmation of the appropriateness of the formulated safety management plan and the appointed safety manager
- Confirmation of the implementation of safety management plan
- Confirmation of the appropriateness of plans for operation routes of construction vehicles and instructions for vehicle operation, and the implementation of the plan
- Confirmation of workers welfare programs and provision of holidays and resting periods

3) Construction Supervision in Japan

In Japan, the Consultant shall establish a system necessary for the comprehensive supervision of the Project described below and perform overall supervision of activities:

- Confirmation on contents of the contract, and the schedule, progress and quality of the construction works
- Provision of solutions to troubles on the site and instructions to the Contractor
- Technical and financial support to the local office of the Consultant

To conduct the following, the Consultant should establish an appropriate organization in Japan:

- Quality management of materials and equipment to be manufactured in Japan (confirmation of shop drawings and other documents, factory inspection, verification of test results, etc.)

2-2-4-5 Quality Control Plan

The Consultant confirms the quality of construction, materials and equipment described in the contract documents (technical specifications and execution plan of the Contractor). If the quality is unsatisfactory, the Consultant shall alert the Contractor and request necessary amendments as well as countermeasures. Quality management shall be performed through the following means:

- Review of catalogs, specifications, and shop drawings for materials and equipment
- Review of results of test and factory inspection for materials and equipment and / or witnessing the tests / inspections
- Review of installation manuals, on-site test, adjustment, inspection manuals and shop drawings for materials and equipment
- Supervision of on-site installation, and witnessing test operation, adjustment and site inspections
- Check of construction drawings prepared by the Contractor
- Inspection for soil compacting, bar arrangement, concrete strength, etc. during construction works
- Confirmation of work performances at site as well as construction methods
- Check of “as-built drawings” for the facilities

Table 2-2-40 shows the major items for the quality management.

Table 2-2-40 Quality Control Plan

Work Item	Item to be Checked	Method	Frequency
Material of Piping	Strength, dimension and workmanship	Factory inspection report, Visual inspection and measurement of dimension	Every approval Every delivery
Installation of Piping	Joints and water leakage	Pressure test	Every joints and whole length of pipelines
Pavement	Base course	Plate load test	By location of pavement
Bedding	Bearing capacity	Plate load test	By structure
Concrete	Aggregate	Grain size test	Every 3000m^3
	Cement	Physical & chemical test	Every 1000ton
	Ready mixed concrete	Slump, air, and chlorides	Every placement of concrete
	Concrete strength	Compressive strength test	Every 100m^3
Reinforcing Bar	Bar arrangement	Visual and dimensional measurement	Every placement of concrete
Workmanship for Structure	Dimension	Visual inspection and dimensional measurement	All major components
Water Proofing	Material quality, thickness and water leakage	Confirmation of material quality certificates. Visual inspection and water filling test	Every approval By structure
Mechanical Installation	Accuracy of installation and function	Installed location	By major equipment
Electrical Installation	Accuracy of installation and function	Sequence test and insulation resistance test	By major equipment

Source: JICA Survey Team

2-2-4-6 Procurement Plan

(1) Sources of Procurement of Materials and Equipment

The materials and equipment for the construction of facilities will be procured locally, if satisfying requirements for the specifications, quality, volumes and periods of delivery.

If the materials and equipment will not satisfy such requirements, they will be procured from Japan or the third counties, based on the principles of the Japan's Grant Aid.

All materials and equipment except cement and aggregates are necessary to be imported because major materials and equipment for civil works are not produced in Palau,. The sources of major materials and equipment for facility construction are planned as listed in Table 2-2-41.

Table 2-2-41 Source of Procurement of Facility Construction Materials

Item	Source of Procurement			Remarks
	Palau	Japan	Third Country	
[Equipment and Material]				
Cement	○			
Aggregate	○			
Ready-mixed Concrete	○			
Reinforcing bar	○			
Steel material	○			
Formwork material	○			
Scaffolding & timber material	○			
PVC(Polyvinyl Chloride) pipe		○	○	US, South Korea
DCIP (Ductile Cast Iron Pipe)		○	○	Taiwan, US
Steel pipe, other pipe material		○	○	Taiwan, US
Valves		○	○	US
Flow meter and Water level meter	○	○		
[Construction Machinery]				
Aggregate plant	○			
Concrete plant	○			
Dump truck	○			
Back hoe	○	○		
Concrete mixer truck	○	○		
Concrete pump truck	○	○		
Generator	○	○		
Truck with crane	○	○		
Bulldozer	○	○		
Road surface cutter	○	○		
Road sweeper	○	○		
Asphalt finisher	○	○		
Road Roller	○	○		
Tired Roller	○	○		
[Others]				
Fuel (Gasoline, diesel oil)	○			

Notes: South Korea = The Republic of Korea, US = The United States of America
Source: JICA Survey Team

(2) Transportation of Materials and Equipment

The transportation of construction materials and equipment procured from Japan or the third countries includes the distanced marine transportation, unloading at Malakal international port, inland transportation from the port to warehouses and materials storage yards, and storage. The main roads from Malakal international port to the warehouses and materials storage yards are sufficient for the traffic of large trucks in terms of pavement surface and road width. No significant difficulty is expected for the inland transportation.

2-2-4-7 Operation Guidance Plan

The Contractor shall implement an initial O&M guidance and training for all the facilities to be constructed, in principle. The Japanese engineers shall conduct the initial O&M guidance as an on-the-job training based on O&M manuals after construction when delivering to PPUC. Table 2-2-42 shows the contents of the guidance and training for the pipelines and the service tank.

Table 2-2-42 Contents of Initial O&M Guidance and Training (Draft)

No.	Facility	Contents	Days
1	Water service tank	Calling names of devices / specifications and functions Operation for water level control Regular inspection / cleaning Valve operation Procurement method for spare parts Operation of district flow meter	15
2	Pipeline and auxiliary devices	Locations and length of pipeline, materials and specifications Maintenance of valves (inspection, maintenance, repair)	7

Source: JICA Survey Team

2-2-4-8 Soft Component (Technical Assistance) Plan

(1) Background of Planning Soft Component

The Project is aiming at stable water supply to five (5) water distribution zones in Koror and Airai States through improvement and/or rehabilitation of water supply facilities. Implementation of the Project will realize improvement of capacity of transmission main and service pressure on water distribution pipelines, and reduction of NRW ratio. The water supply service is improved, so that the residents are able to secure the stable drinking water.

Although NRW is a serious issue, NRW management and technology of leak detection are insufficient for PPUC. It is difficult to reduce NRW ratio effectively only with facility improvement. Accordingly, the Project aims to have the synergy between improvement/rehabilitation of facilities and the Soft Components which is to conduct technical guidance for water distribution management and leak detection.

1) Financial Management

Although PPUC is required to be sustainable by tariff incomes, 62% of the expenditure is appropriately covered by the Governmental subsidy. The cost recovery rate is only 38%. Since the management capacity is insufficient, PPUC is supported by the ADB for sewerage improvement and program loans for water sector. Under such circumstances, PPUC commenced the tariff improvement for the water and wastewater, based on the ADB recommendations in 2009. Although the tariffs were revised in 2011 and 2012, the income has not reached a possible level for cost recovery. Currently, PPUC makes efforts to have the community's understanding through campaigns for tariff improvement.

Besides the tariff improvement, NRW ratio (currently 48%) should be decreased in order to reduce the cost regarding water transmission and distribution.

2) Distribution / NRW Management in Water Distribution System

The Project shall commence measurement of water distribution flows at each service tank. Nevertheless, the customers and sales management zones are not in conformity with the water distribution zones. Accordingly, it is not able to compare the water flow data between distributed volume and sold volume (billed volume). It is caused by insufficient understanding on NRW and water distribution management. Since NRW ratio is high, the management procedures should be established for water distribution, in parallel with facility improvement.

3) Leak Detection on Existing Lateral Pipe

It is sometimes difficult to detect water leakages on lateral pipes. It is because that 1) lateral pipelines are long in private plots, and 2) structures and / or pavement are constructed on the lateral pipes.

Accordingly, it is necessary for PPUC to improve their skill to detect water leakages quickly and appropriately, and to prepare proper detection programs. In addition, they need to develop their capacity for leak detection in order to maintain the effectiveness of NRW reduction in the future.

Furthermore, it will be recommended to add a function on water distribution management in the existing O&M section and to continue activities for achieving the target of NRW reduction.

4) Improvement of Leak Detection Technique for Staffs and Planned Water Leakage Prevention

PPUC has one set of leak detector (ground microphone) and one set of leak correlator. Nevertheless the leak correlator has not been left unused since some of the parts were lost. The ground microphone is in good condition, and one of PPUC staff members can operate it. The leak detection is, however, sometimes difficult for the PPUC staff member.

Since the skill and equipment are insufficient, it is difficult to complete the surveys for frequent water leakage. Currently scheduled detection works, which is necessary to reduce NRW, are not conducted. Accordingly, the following items are necessary for NRW management:

- To prepare a program for leak detection
- To prepare sufficient number of equipment
- To improve skills for leak detection

(2) Targets for the Soft Component

The target for the Soft Component of the Project is to enable PPUC staffs to conduct the following works continuously after the completion of the Project:

- To manage data for water transmission and distribution in accordance with manuals, and to maximize the effectiveness of the facility utilizing the analyzed data
- To learn the leak detection skill, to make plans for leak detection survey, and to implement the leak detection

(3) Output of Soft Component

The contents of the Soft Component are described as follows:

- Management of water transmission/distribution and NRW volumes, and utilization of analyzed data for the whole water supply system
  - ✓ To record water distribution flow using a flow meter at each service tank
  - ✓ To make a customer list, including water consumption by water distribution zone
  - ✓ To grasp NRW volume using customer consumption and water distribution volume quantitatively
  - ✓ To manage NRW data
- Promotion of leak detection technique and planning and implementation of leak detection.
  - ✓ To identify water leakages properly
  - ✓ To obtain leak detection skill as well as utilization of equipment in accordance with the manual
  - ✓ To make a scheduled work program for leak detection
  - ✓ To feedback water leakage information to management plan of water transmission main /distribution pipeline

(4) Methods for Confirming Achievement of Outputs

The achievement level for outputs from the Soft Component will be confirmed with the acquired knowledge and improvement of daily routine works.

- Acquirement level on knowledge: small tests at the end of training
- Daily work improvement using acquired knowledge: monitoring of work

Table 2-2-43 shows the check items for output achievement level of the Soft Component.

Table 2-2-43 Method of Evaluation of Achievement

Category	Output	Evaluation Items
Management of water transmission/distribution and NRW volumes, and. utilization of analyzed data for the whole water supply system.	To record water distribution flow using flow meter at each service tank.	✓ To record water distribution flow, and sort out accurately by graphs.
	To make customer list, including water consumption by water distribution zone.	✓ To coordinate the billed water data (consumption data) with each water distribution zone using the customer list.
	To grasp NRW volume using customer consumption and water distribution volume quantitatively.	✓ To calculate NRW volume on distribution / lateral pipes, using water distribution flow data and customer consumption data. ✓ To calculate NRW volume on transmission main, using water level data of every distribution service tank and data of outlet flow meter at KAWTP.
	To manage NRW data.	✓ To prioritize water distribution zones for leak detection, using data of NRW ratio and the customer list.
Promotion of leak detection technique and planning and implementation of leak detection	To identify water leakages properly. To learn leak detection skill as well as utilization of equipment in accordance with the manual.	✓ To understand principles and characteristics of the leak detection equipment. ✓ To use equipment in accordance with the manual. ✓ To identify water leakages properly.
	To make a scheduled work program for leak detection. To feedback water leakage information to management plan of water transmission main /distribution pipeline.	✓ To make and implement leak detection schedule with NRW reduction plan. ✓ To make a report of water leakage location record. ✓ To feedback the cause of water leakages to improvement of water transmission main /distribution pipelines maintenance plan after leak detection.

Source: JICA Survey Team

(5) Soft Component Activities (Input Plan)

1) Contents of the Soft Component

The activity contents of the Soft Component are as follows. The work schedule is shown in Table 2-2-44.

- Preparation of training schedule
- Preparation of training text (manuals)
- Preparation of templates of water distribution flow, customer consumption and NRW (MS-Excel)
- Practical training of screening survey and ground microphone survey for leak detection
- Implementation of lectures / practices
- Preparation of report of water leakage repair
- Preparation of the water leakage prevention plan / NRW reduction plan
- Evaluation of the achievement (output as a report)

In addition, 2 sets of leak detector (ground microphone and electric/non-electric listening stick) are procured for leak detection training. This equipment is able to detect water leakage for both water distribution pipelines and lateral pipes. Furthermore, this equipment is easy to handle even though new staff members.

Table 2-2-44 Implementation Schedule (Proposed)

Category	Training	Days																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Water Distribution Analysis	NRW management																														
	Distribution Zones Investigation																														
Leakage Detection Technique	Leakage Detection Plan/Analisis of Water Distribution Flow																														
	Lateral connection /Ground Surface Survey																														
	Confirmation																														

Source: JICA Survey Team

2) Trainer for the Soft Component

Two (2) Japanese consultants are deployed as trainers of the Soft Component. One (1) expert is for water distribution analysis and another expert is for water leak detection.

3) Candidate Trainees

The candidate trainees are ten (10) personnel from WWO and Administration in PPUC. In addition, these candidate participants should be informed to JICA Palau Office from PPUC until the intermediate time of the construction period.

- The candidate trainees are mainly the person(s) in charge of O&M for facilities, which is constructed by the Project.
- Although the trainees are divided into two (2) teams for water distribution analysis and for leak detection, all ten (10) personnel are able to learn and understand the training contents of the both parts.

(6) Procurement of Trainer Resources of the Soft Components

The Soft Component is to support overall management for Koror - Airai water supply system and to support utilization of the leak detection skill.

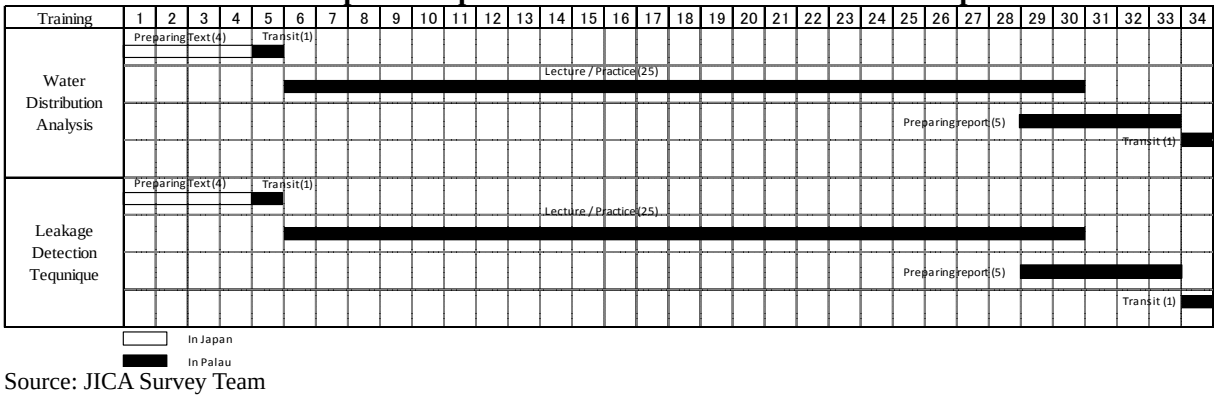
Accordingly, the trainer in charge of the overall management is required to be familiar with this water distribution system and involved in the design of facilities. On the other hand, the trainer for leak detection is required to be familiar with leak detection equipment. These are reasons that a direct support program by the Japanese Consultant is required.

(7) Implementation Schedule for the Soft Component

The Soft Component will be conducted after completion (or nearly completion) of facilities and / or trial operation period since the activity requires the operation of the facilities.

Table 2-2-45 shows the proposed implementation schedule of the Soft Component for the Project.

Table 2-2-45 Proposed Implementation Schedule for the Soft Component



Source: JICA Survey Team

(8) Deliverables in the Soft Component

Deliverables in the Soft Component are listed in Table 2-2-46

Table 2-2-46 Documents to be Prepared in the Soft Component

Items	Remarks
Data management manual of NRW	Record sheet of water distribution flow and customer consumption Record of calculated NRW
Leak detection manual and the survey program plan	Proposed leak detection program plan Screening survey manual (individual houses, ground surface survey)
Evaluation report on achievement of trainees	Evaluations and results of small test and Q&A sheet for trainees
Final report for the Soft Component (English)	Conforming to the 3rd edition (October in 2010) of the Soft Component guideline of JICA
Final report for the Soft Component (Japanese)	Same as the above

Source: JICA Survey Team

(9) Responsibilities of the Implementation Agency

1) Viability for Implementation

The objectives and contents of the Soft Component in the Project are desirous ones for PPUC to improve cost effectiveness of water supply. Accordingly, the viability of the Soft Component is very high.

In order to achieve the objectives of the Soft Component, institutional and financial conditions of PPUC should be guaranteed.

Currently, PPUC has thirty five (35) staff members in total related to the O&M for water supply facilities. It is considered that O&M for the facilities to be constructed in the Project can be conducted by the exiting staffs or reallocation/rotation of the current staff members.

In addition, for the financial conditions, PPUC's expenditure for activities in the Soft Component is estimated as little. It is, therefore, considered that PPUC is capable to undertake necessary activities in the Soft Component.

2) Impeding Factor and Required Action by PPUC

No impeding factors are expected in training items. The trainees, however, may have business trips sometimes for emergency / accidents in outlaying states. To prepare for such situation, average training hours per day should be planned for three (3) to four (4) hours.

PPUC and the trainees for the Soft Component should satisfy the following requirements. In order to satisfy these requirements, PPUC is required to have the candidate trainees obtain the necessary skills. Besides, key personnel for O&M should be trained for all the items of the Soft Component.

- To learn a basic skill to use a computer system (MS-Excel and MS-Word).
- To secure enough time necessary for class-room training and practical training (3 to 4 hours a day).
- To secure training room: one (1) room having enough space for 10 to 15 trainees in PPUC office.

PPUC should arrange the hardware such as computers before the training for the data management of water distribution flow and NRW volume. For the hardware of the training, JICA Survey Team had already confirmed at the time of outline design stage that PPUC had all necessary equipment including computers and they were able to utilize their hardware for the training.

In the activity for leak detection technology and prevention planning, the survey includes "nighttime activity". PPUC should prepare safety arrangement for prevention of traffic accidents before the activity. The nighttime overwork payment is also required for trainees.

2-2-4-9 Implementation Schedule

Facility construction in the Project is executed after E/N between the two countries following the cabinet approval by the Japanese Government. The implementation of the Project requires approximately 29 months, including the detailed design, tender procedures, construction and soft component.

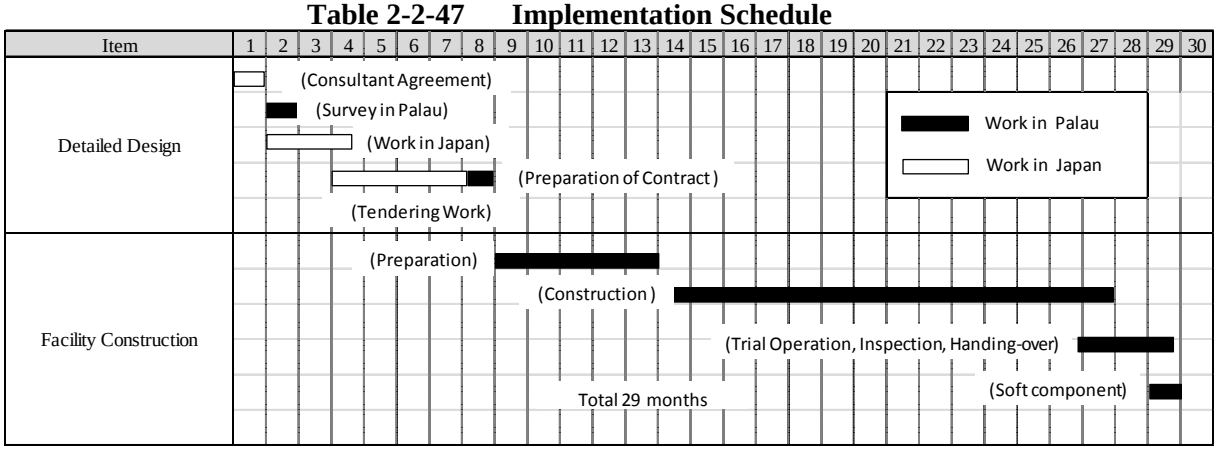
The detailed design needs to be developed for the accuracy to be necessary in the specification documents for tendering. This work consists of one field study (research and discussion for confirmation of design contents) and design works in Japan. The required time is expected to be 3 months.

After detailed design, tendering is conducted for construction contract. Facility construction, including preparation, construction works and inspection/test operation, will require approximately 21 months from the conclusion of contract until completion of works.

After the completion (or nearly completion) of works, the Soft Component will be executed in Palau for improvement of O&M capacity. The necessary period for the Soft Component is approximately 1 month.

Table 2-2-47 shows the implementation schedule for the construction work by the Japanese side based on the above requirements.

Table 2-2-47 Implementation Schedule



Source: JICA Survey Team

2-3 Obligations of Recipient Country

The Project is composed of Japanese cooperation and the works to be undertaken by the Palauan side with their self-effort. Table 2-3-1 shows the summary of obligatory works to be implemented by the Palauan side. The obligatory works are divided into three implementation stages: before the commencement of the Project, during the construction period for the Project and after the completion of the Project.

Table 2-3-1 Obligatory Items and Implementation Stages

No.	Items of Obligation	Project Period		
		Before	During	After
1	To obtain authorization for the Project implementation (environment and occupation of road space).	✔		
2	To explain the Project to the residents living near the facility construction site and hold stakeholder meetings.	✔	✔	
3	To secure the land for construction site of the Project facilities through legal procedures properly.	✔		
4	To improve the existing access roads to the facility construction sites for the Project.	✔		
5	To provide temporary storage place for construction materials.	✔		
6	To provide disposing places for surplus soil and wastewater.		✔	
7	To take necessary procedures to issue A/P required for payments to the Japanese Consultant and/or Contractor(s), and to bear the following commissions to a bank in Japan for the banking services based upon the Banking Arrangement. ✓ Advising commission of A/P ✓ Payment commission		✔	
8	To obtain construction permissions of the authorities (EQPB, Koror State Government) related to pipe laying work.		✔	
9	To provide power and to fix a power cable required for service tanks (the devises after the power receiving panel are the scope of the Japanese side).		✔	
10	To ensure prompt unloadings and customs clearances of the goods for the Project at the port of disembarkation in Palau.		✔	
11	To accord Japanese nationals whose services may be required in connection with the supply of products and services under the verified contract(s) such facilitation as may be necessary for their entry and stay therein for the performance of their works.		✔	
12	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Palau with respect to the supply for the products and services under the verified contract(s), and to take necessary measures for such tax exemption.		✔	
13	To switch over lateral pipe connection.		✔	
14	To assign candidate staff members for soft component and inform them of JICA Palau office.		✔	
15	To install fences and gates around the yards for planned service tank in the Project.		✔	
16	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment.		✔	
17	To use and maintain properly and effectively all the facilities constructed, and equipment and materials provided under the Japan's Grand Aid.			✔

Source: JICA Survey Team

Table 2-3-2 shows the cost estimation that PPUC shall bear for facility construction and other civil works among the above obligations.

Table 2-3-2 Cost Estimations for Obligatory Works by Recipient Country (PPUC)

No.	Items of Obligation	Estimated Cost (USD)
1	Improvement of access road to Malakal service tank (Approximately 667ft: 200m)	23,645.30
2	Provision of required power cable for service tanks	6,580.00
3	Installation of fences and gates around Malakal service tank	32,066.44
4	Replacement of lateral connections (308 units) and lateral pipes	168,528.36
	Total	230,820.10

Source: JICA Survey Team in accordance with discussion results with PPUC

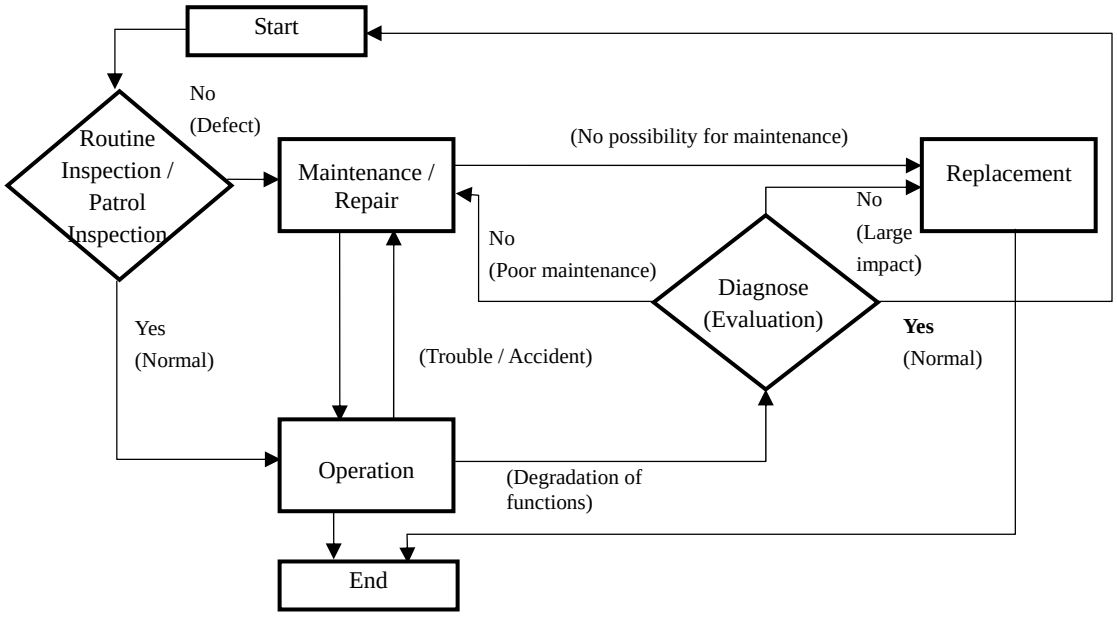
As shown in the above table, the cost for the obligatory works by Palauan side is estimated at USD231 thousand (JPY25 million). When it is distributed over two fiscal years, it is USD68 thousand (JPY7 million) in FY2015/2016 and USD163 thousand (JPY17 million) in FY2016/2017.

The cost (electricity charge for water transmission pumps) reduction, which is realized by water leakage reduction, is estimated 265,078kWh×USD0.427/kWh=USD113,188 per year. Therefore, it is possible to recover the cost for obligatory works by PPUC in five (5) to six (6) years. Nevertheless, PPUC should make an application to GoP for financial support to cover the above cost within the Project period.

2-4 Project Operation Plan

2-4-1 Basic Policy

For long-term effective use of the facilities constructed under the Project and for stable and continuous water supply reflecting the fluctuation in daily demand, operation and management of facility and protection of environment for facilities are indispensable. The Palauan side should carry on suitable preventive maintenance which aims at keeping reliability, safety, efficiency, functions of facilities to secure the stable water supply. Figure 3-3-1 shows the basic policy of maintenance of the facilities in the Project.



Source: Guideline for Maintenance of Water Supply Facilities in Japan

Figure 2-4-1 Maintenance Flow of Water Supply Facilities

The Contractor will give technical guidance to PPUC on O&M of each equipment installed in the contract period. Meanwhile, the Consultant will conduct the Soft Component (or technical assistance) on management of water distribution flow and reduction of NRW in the Project.

2-4-2 Items for Periodic Inspection

Based on the policy mentioned above, the following points are the basic items that PPUC shall conduct in operational management and maintenance of the water pumping and distribution facilities.

Operational management:	Conducting operation and monitoring of equipment under normal conditions
Maintenance:	Conducting maintenance, repair and preparation so that facilities and equipment can be operated with their full capability

Table 2-4-1 shows the main items for O&M of the new water supply facilities.

Table 2-4-1 Main Items of O&M for Facilities Constructed in the Project

Classification	Main Items
Operational Management	**[Water Volume Control]** 1) Controlling equipment and devices conforming to the target water volume **[Non-Revenue Water Management]** 2) Regularly observing water transmission flow and distribution flow for each service tank. Managing NRW with comparing to tariff collection data. Conducting periodical leak detection using the procured equipment.
Maintenance	**[Inspection Item]** 1) Inspecting and checking facilities, equipment and devices with meters and naked eyes, repairing and maintaining faults or breakdowns, and additionally securing and protecting safety of chemicals (chlorine) needed for disinfection. **[Prevention]** 2) Renewing facilities, equipment and devices periodically depending on the importance and characteristics even without any breakdowns. This leads to increase of safety and reliability, as well as stable operation of the facilities.

Source: JICA Survey Team

PPUC is required to carry out an appropriate O&M of each equipment according to O&M manuals of each equipment supplied by those makers.

2-4-3 Spare Parts Purchase Plan

Spare parts are divided into (a) consumable parts which may be replaced periodically and (b) replacement parts for emergency cases, which are necessary for accidents, etc. It is, therefore, necessary that the Palauan side shall prepare main items in accordance with the periodical inspection cycle and appropriate time.

In difficult cases for the Palauan side to contact with the manufacturers, the Contractor and the Japanese consultant should assist the necessary procurement procedures.

2-4-4 Structure for Operation and Maintenance

Regarding the organization, WWO is in charge of O&M of the Project. The staffs of KAWTP and others, except for outlying state, are in charge of the facilities to be constructed.

Inefficiency derived from NRW and leakage is a subject to be improved. In order to deal with it, it is necessary to add functions of analyzing and managing of water distribution volume and NRW at the O&M department for KAWTP and Koror and Airai States.

Even though adding the above management functions, it is not necessary to establish new department or to recruit new staff members. It can be managed by the existing departments.

If staff members become insufficient in number due to adding new management function for water distribution and leak detection, it is recommended to shift three (3) persons from Outlying States in Babeldaob island to the existing O&M works for Koror-Airai Water Supply System as shown in Table 2-4-2.

Table 2-4-2 Staff Members for O&M in the Project

Department, Title	Staffs (Current)	Staffs (Proposed)
Headquarter (administration staff)	16 persons	16 persons
O&M personnel from Airai and Koror-Airai Water Treatment Plant ➢ Water treatment plant management ➢ Water pumping and distribution management ➢ NRW analysis and management (additional) ➢ Water quality monitoring and supervising (additional)	35 persons	38 persons (+3 persons)
O&M personnel from outlying state (abolish or merge with adjacent state)	43 persons	40 persons (-3 persons)
O&M personnel in sewerage and sewerage treatment plant	21 persons	21 persons
Total	115 persons	115 persons

Source: JICA Survey Team

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Cost to be Borne by Japanese Side

This information is closed due to the confidentiality.

(2) Cost to be Borne by Palauan Side

The cost to be borne by the Palauan side for the Project is as mentioned in Chapter-3. The estimated cost for undertakings by the Palauan side is USD 230,820.10 or JPY 25 million (refer to Table 2-3-1).

(3) Conditions for Cost Estimation

Conditions for the above estimation are as follows:

1. Starting Date of Estimation: November 2014
2. Exchange Rate: Average of the last 3 months from October 31st, 2014

   USD1.00 = JPY 107.02
3. Execution Period: Facility construction in one Japanese fiscal year
4. Others: The Project shall be implemented under the Japan's Grant Aid scheme

2-5-2 Operation and Maintenance Cost

(1) O&M Cost

The additional O&M cost of water facilities to be constructed by the Project is for electricity and spare parts of the water level monitoring system at Malakal service tank. Few costs will be required for water transmission and distribution lines. As for labor, additional cost will not be required, since the management of water distribution and NRW is conducted by the existing department and personnel.

Table 2-5-1 shows the cost estimation results under the below conditions.

Electricity Charge: Annual Power Consumption x Average electricity charge

Spare Parts Cost: Price of Equipment x 3%/year

According to the Project implementation, O&M cost will be increased by USD 640.00 per year. PPUC is able to afford this increased cost since the cost for electricity charge for water transmission pumps will be reduced along with water leakage reduction. The reduced electricity charge is estimated 265,078kWh x USD 0.427/kWh=USD 113,188 per year

Table 2-5-1 Operation Management Cost after Implementation

Items		A	B	C	D [A×B×C]	E [D×365day/year]	F	G [E×F]
		Output (kW)	Number in Duty Unit (unit)	Operating Hour (hr/day)	Daily Power Consumption (kWh/day)	Annual Power Consumption (kWh/year)	Electricity Charge (USD/kWh)	Annual Expenses (USD)
Electricity Charge	Water Level Gauge	0.12	1	24	2.88	1,051	0.427	448.00
Items		A	B					C [A×B]
		Price of Equipment (USD)	Ratio for Spare Parts (%/year)					Annual Expenses (USD)
Spare Parts Cost	Water Level Gauge	6,400	0.03					192.00
Increment of Expenditure with the Project Implementation Total								640.00

Source: JICA Survey Team

(2) Renewal Plan for Equipment

In the Project, water level monitoring system will be installed. Table 2-5-2 shows the service life of this equipment.

Table 2-5-2 Service Life of Equipment for Water Level Monitoring System in the Project

Equipment	Service Life
Water Level Gauge	15years

Source: JICA Survey Team

CHAPTER 3

PROJECT EVALUATION

CHAPTER 3 PROJECT EVALUATION

3-1 Preconditions

PPUC has conducted a negotiation with the Koror State Government on utilization of the proposed site for the Malakal service tank because this site is managed by Koror State Government. KSPLA has issued an authorization for the site utilization to PPUC (February 2015). Based on it, PPUC should take the registration process for the site utilization.

For the site utilization, resettlement is not required, but private farms extend over the site. Before construction of the Malakal service tank, it is required to remove a part of these farms interfering with construction. PPUC should implement this removal peacefully with cooperation of Koror State Government.

For customs clearance and tax exemption for products procured in abroad, the Contractor should submit “application for customs clearance and tax exemption” with a copy of bill of lading / airway bill and other necessary documents to Bureau of Revenue, Customs and Taxation in Ministry of Finance beforehand through PPUC’s procurement officer. At the same time, a copy of the application should be submitted to Bureau of International Trade and Technical Assistance in Ministry of State. Through the mentioned procedures, the import tax (3%) is completely exempted, but not in refunded method. In addition, there is no consumption tax (VAT) for commodity in Palau.

The major undertakings to be taken by the Palauan side are; to prepare the access road to Malakal service tank; to supply electricity to the tank; to construct a fence and gate around the site for the tank; and connect lateral pipes for house connections. For these works, the total cost born by the Palauan side is estimated as USD231 thousand (JPY25 million). It can be recovered in 5 to 6 years because cost reduction (electricity charge for water transmission pumps) will be realized by water leakage reduction. Nevertheless, PPUC should make an application to GoP for financial support to cover the above cost within the Project period. It should be noted that PPUC has already started preparation for taking budgetary steps to be funded at proper time.

3-2 Necessary Inputs by Recipient Country

The following items are necessary inputs by the Palauan side in order to develop and sustain the effects of the Project.

1) To use and maintain properly and effectively all the facilities constructed, and equipment and materials provided under the Project
2) To assign staff members properly in charge of O&M for the facilities constructed under the Project
3) To establish an appropriate O&M system following the data management manual for transmission / distribution flows and leak detection program
4) To establish mitigation measures and to conduct environmental management and monitoring plans for environmental and social considerations

At present, ADB supports for water sector of Palau through program loans. With this program loans, several works, such as installation / replacement of customer meters and installation of water transmission pumps in KAWTP, are being implemented. It will complement the effects of the Project.

3-3 Important Assumptions

The following items are important assumptions to develop and sustain the effects of the Project.

1) Water Demand of Consumers

The facilities of the Project are designed on the basis of the current water supply (water demand). It is expected to decrease the water supply by water leakage reduction. Nevertheless the design water

supply may be insufficient if water leakage and wastage of water will be increased at the equipment managed by customers and service pipes in private lands. In this case, fair and proper water distribution will be difficult, and uneven distributions of benefit will be newly generated. Accordingly PPUC should take countermeasures against water leakage at the equipment managed by customers and service pipes in private lands, and implement activities for raising public awareness to save water.

2) Management improvement and Optimization of WWO in PPUC

Operation of WWO should be optimized through NRW reduction and efficient assignment of staff members. Through this Project aiming to improve water supply system, it is expected to improve management of WWO by NRW reduction. Nevertheless, it is possible to reduce the effects of the Project if staff arrangement and other management resources will not be optimized. Consequently PPUC should make efforts not only for NRW reduction, but also for optimization of staff arrangement and other management resources.

3) Replacement of Lateral Pipes

PPUC will connect lateral pipes for house connections as one of the major undertakings in the Project to be taken by the Palauan side. Since the existing lateral pipes are aged and installed at inappropriate positions, they are ones of the reasons for water leakage. Accordingly it is recommended that PPUC will replace lateral pipes in parallel with the Project. This replacement is expected to reduce NRW more effectively.

3-4 Project Evaluation

3-4-1 Relevance

Relevance of the Project is evaluated as follows.

1) The current water demand (daily maximum production) is approximately 4.0MG/day (15,140m^3/d). Nevertheless, the capacity of existing water transmission facility is extremely insufficient, which is only 2.1MG/d (7,950m^3/d). It is indispensable to increase this capacity.

2) A hilly area (Ngerbeched area) in Koror Island suffers from low service pressures, which are under the designated minimum dynamic pressure. It is highly required to improve the distribution balance and to settle a low service pressure area by re-arrangement of water distribution zones including establishment of Malakal water distribution zone.

3) NRW ratio reaches 48%, and most of NRW is presumably caused by water leakage. This water leakage wastes energy (electricity) for treatment and transmission. It is required to decrease costs for treatment and transmission, and to improve the efficiency by reduction of NRW. Accordingly it is critically important to replace the aged AC pipes.

The Project site is the economic center of Palau. And a number of foreign visitors is increasing. Under such situation, it is quite important for the economy of Palau to supply water stably to the central part of Koror State and Airai State.

3-4-2 Effectiveness

(1) Quantitative Effects

The purpose of the Project is to ensure stable water transmission for Koror and Airai States. Table 3-4-1 shows the key indicators to measure quantitative effects for expected outcomes of the Project.

Table 3-4-1 Indicators of Quantitative Effects by the Project

Indicator	Baseline (as of year 2013)	Target (3 years after the completion, planned as Year 2020)
Capacity of clear water transmission[1]	2.1MG/day (7,950m^3/day)	4.0 MG/day (15,140m^3/day)
Service Pressure in the Project area[2]*	Less than 2psi (0.014MPa)	More than 20psi (0.14MPa)

Notes：*Ngerbeched area, the lowest pressure area in the Project area shall be the monitoring area.
Source： JICA Survey Team

(2) Qualitative Effects

The Qualitative Effects are as follows;

Living environment for the citizens is improved by achieving the stable and even water supply through the Project[3]. Furthermore, leak detection activities and water distribution management become easier to conduct for PPUC by the re-arrangement of water distribution zones[4].

[1] At present, operators at KAWTP measure water transmission volume every hour with flow meter. This measurement will be continued to evaluate the indicator.
[2] As setting a baseline, PPUC measured the water service pressure at 5 points in Ngerbeched area (the lowest pressure area as shown in the Figure 2-2-31) on October 16th, 2014. To evaluate the indicator, staff of WWO will continue to measure the water service pressure at the same 5 points once a month (at 7 pm on every first Wednesday).
[3] The Project enables the stable water distribution with the fair water service volume and pressure. Consequently the water service will be improved.
[4] The Project provides leak detection activities and water distribution management by 1) data arrangement for both consumption and distributed flow for the distribution zones, and 2) data acquisition of the water distribution volumes by the flow meters at the service tanks.

APPENDICES

[Appendices]

1. Member List of the Survey Team

2. Survey Schedule

3. List of Parties Concerned in the Recipient Country

4. Minutes of Discussions

5. Soft Component (Technical Assistance) Plan

6. Sector Development Framework

7. Result of Water Quality Analysis 1

8. Result of Water Quality Analysis 2

9. Result of Test Pit Survey

10. Result of Soil Investigation

11. Result of Topographic Survey

12. Result of Leak Detection

13. Result of Social Condition Survey

14. Technical Notes

15. Environmental Checklist

16. Monitoring Form

Appendix-1

Member List of the Survey Team

Member list of the Survey Team

（First Field Survey）

Name	Role	Period	Organization
Ms. TAMURA Eriko	Team Leader	22 June, 2014-27 June, 2014	Director, Water Resources Management Division 1 Water Resources and Disaster Management Group Global Environment Department
Mr. OMURA Yoshiki	Water Supply Planning	22 June, 2014-27 June, 2014	JICA Senior Advisor
Ms. KAMATA Hiroko	Sewerage Planning	22 June, 2014-18 July, 2014	JICA Senior Advisor
Mr. HASHIMOTO Hiroki	Project Planning	22 June, 2014- 27 June, 2014	Officer, Water Resources Management Division 1 Water Resources and Disaster Management Group Global Environment Department
Mr. FUJII Katsumi	Chief Consultant/ Water Supply Planning	22 June, 2014- 11 July, 2014 23 July, 2014- 6 Aug, 2014	Yachiyo Engineering Co., Ltd.
Mr. IGARASHI Hideyuki	Deputy Chief Consultant/ Water Supply Planning/ Purification Facility Planning & Design/ Operation & Maintenance planning	8 July, 2014- 1 Aug, 2014	Yachiyo Engineering Co., Ltd.
Mr. SENO Masatoshi	Facility Planning & Design (Reservoir, Pumping Station)	8 July, 2014- 6 Aug, 2014	Yachiyo Engineering Co., Ltd.
Mr. SHIRAISHI Toshihiro	Pipeline Planning & Design	8 July, 2014- 6 Aug, 2014	Nihon Suiko Sekkei Co., Ltd.
Mr. SHIMOOSAKO Hiroshi	Ground Water Development	22 June, 2014- 21 July, 2014	Yachiyo Engineering Co., Ltd.
Mr. KAGAWA Shigeyoshi	Environmental and Social Considerations	23 June, 2014- 22 July, 2014	Nihon Suiko Sekkei Co., Ltd.
Mr. TSUNOJI Hiromi	Construction Plan/ Procurement Plan/ Cost Estimate	3 July, 2014- 1 Aug, 2014	Yachiyo Engineering Co., Ltd.
Mr. KASUYA Toshinobu	Coordinator/ Cost Estimate Assistant	22 June, 2014- 21 July, 2014	Yachiyo Engineering Co., Ltd.

（Second Field Survey）

Name	Role	Period	Organization
Ms. TAMURA Eriko	Team Leader	7 Oct, 2014- 10 Oct, 2014	Director, Water Resources Management Team 1 Water Resources and Disaster Management Group Global Environment Department
Mr. FUJII Katsumi	Chief Consultant/ Water Supply Planning	21 Sep, 2014- 20 Oct, 2014	Yachiyo Engineering Co., Ltd.
Mr. IGARASHI Hideyuki	Deputy Chief Consultant/ Water Supply Planning/ Purification Facility Planning & Design/ Operation & Maintenance Planning/Transmission Pipeline Planning &Design	8 Oct, 2014- 6 Nov, 2014	Yachiyo Engineering Co., Ltd.
Mr. SENO Masatoshi	Facility Planning & Design (Reservoir, Pumping Station)	13 Sep, 2014- 12 Oct, 2014	Yachiyo Engineering Co., Ltd.
Mr. SHIRAISHI Toshihiro	Distribution Pipeline Planning & Design	25 Sep, 2014- 24 Oct, 2014	Nihon Suiko Sekkei Co., Ltd.
Mr. ISHIZUKA Okuto	Hydraulic Analysis	3 Oct, 2014- 24 Oct, 2014	Nihon Suiko Sekkei Co., Ltd.
Mr. KAGAWA Shigeyoshi	Environmental and Social Considerations	21 Sep, 2014- 20 Oct, 2014	Nihon Suiko Sekkei Co., Ltd.
Mr. TSUNOJI Hiromi	Construction Plan/ Procurement Plan/ Cost Estimate	21 Sep, 2014- 20 Oct, 2014	Yachiyo Engineering Co., Ltd.
Mr. KASUYA Toshinobu	Coordinator/ Cost Estimate Assistant	13 Sep, 2014- 12 Oct, 2014	Yachiyo Engineering Co., Ltd.

（Draft Final Explanation）

Name	Role	Period	Organization
Mr. OMURA Yoshiki	Team Leader /Water Supply Planning	24 Feb, 2015- 28 Feb, 2015	JICA Senior Advisor
Mr. HASHIMOTO Hiroki	Project Planning	24 Feb, 2015- 28 Feb, 2015	Officer, Water Resources Management Team 1 Water Resources and Disaster Management Group Global Environment Department
Mr. FUJII Katsumi	Chief Consultant/ Water Supply Planning	22 Feb, 2015- 28 Feb, 2015	Yachiyo Engineering Co., Ltd.
Mr. IGARASHI Hideyuki	Deputy Chief Consultant/ Water Supply Planning/ Purification Facility Planning & Design/ Operation & Maintenance Planning/Transmission Pipeline Planning &Design	19 Feb, 2015- 28 Feb, 2015	Yachiyo Engineering Co., Ltd.
Mr. SHIRAISHI Toshihiro	Distribution Pipeline Planning & Design	19 Feb, 2015- 28 Feb, 2015	Nihon Suiko Sekkei Co., Ltd.

Appendix-2

Survey Schedule

Survey Schedule

（First Field Survey）

No.	Day Month Year	Date	Activity	Remarks
1	22 June, 2014	Sun	Departure from Tokyo / Arrival at Koror of JICA officials (Ms. TAMURA、Mr. OMURA、Ms. KAMATA、Mr. HASHIMOTO） Departure from Tokyo / Arrival at Koror of consultant members (Mr. FUJII、Mr. SHIMOOSAKO、Mr. KASUYA)	JICA Officials UA827 Narita･Guam UA157 Guam･Koror Consultant Team NH241 Haneda･Fukuoka UA166 Fukuoka･Guam UA157 Guam･Koror
2	23 June, 2014	Mon	Meeting at JICA Palau Office Courtesy call to Embassy of Japan Kick off meeting with PPUC Discussion with ADB Departure from Tokyo / Arrival at Koror of consultant member (Mr. KAGAWA)	UA827 Narita･Guam UA157 Guam･Koror
3	24 June, 2014	Tue	Field survey in Babeldaob Island and Koror state (Mongami and Ngchemiangel water supply facility / Ngimel Dam・Ngerikiil Intake Pump Station / Planned place for Additional water resource / KB Bridge) Request for cooperation of EQPB	
4	25 June, 2014	Wed	Field Survey in Babeldaob Island and Koror State. (Ngacherong water supply facility、Malakal service tank、Sewage plant、Inspection of Malakal water resources) Discussion with PPUC on M/D	
5	26 June, 2014	Thu	Discussion with PPUC on M/D Survey for existing service tank	
6	27 June, 2014	Fri	Signing on M/D Report to Embassy of Japan	
7	28 June, 2014	Sat	Departure from Koror / Arrival at Tokyo of JICA officials (Ms. TAMURA、Mr. OMURA、Mr. HASHIMOTO） Analysis of collected data	UA158 Koror・Guam UA828 Guam・Narita
8	29 June, 2014	Sun	Analysis of collected data	
9	30 June, 2014	Mon	Meeting with PPUC for data collection method Data collection of Topographic map	
10	1 July, 2014	Tue	Data collection of statistic information Survey for existing well facilities Survey for candidates of sub-contractor	
11	2 July, 2014	Wed	Data collection of measurement of water saving Data collection and analysis of water supply quantity Survey for existing well facilities and abundance of ground water Survey for candidates of sub-contractor	
12	3 July, 2014	Thu	Survey for water quality analysis of Palau International Coral Reef Center Survey for number of foreign visitor Survey for Malakal water resources Data collection of statistic information Departure from Tokyo / Arrival at Koror of consultant members (Mr. TSUNOJI)	UA827 Narita・Guam UA157 Guam・Koror
13	4 July, 2014	Fri	Survey for financial status of PPUC Survey for transmission water quantity of KAWTP Meeting for confirmation of environmental impact Data collection of meteorological data	
14	5 July, 2014	Sat	Analysis of collected data	
15	6 July, 2014	Sun	Analysis of collected data	
16	7 July, 2014	Mon	Survey for existing booster pump station Survey for existing well facilities Meeting for confirmation of environmental impact Survey for candidates of sub-contractor	
17	8 July, 2014	Tue	Survey for related implementing project Survey for disposal method of sludge Survey for financial status of PPUC Survey for existing well facilities Departure from Tokyo / Arrival at Koror of consultant members (Mr. IGARASHI, Mr. SENO, Mr. SHIRAISHI)	UA827 Narita・Guam UA193 Guam・Koror
18	9 July, 2014	Wed	Survey for intake pump station, KAWTP, transmission and distribution water facilities. Survey for existing well facilities	
19	10 July, 2014	Thu	Survey for financial status of PPUC Survey for distribution water facilities Survey for existing well facilities Internal meeting with JICA Palau office	
20	11 July, 2014	Fri	Survey for transmission and distribution water facilities Survey for existing well facilities Data collection of meteorological data IEE support Departure from Tokyo / Arrival at Koror of consultant members (Mr. FUJII)	UA158 Koror・Guam UA828 Guam・Narita
21	12 July, 2014	Sat	Analysis of collected data	
22	13 July, 2014	Sun	Analysis of collected data	
23	14 July, 2014	Mon	Survey for service tanks Survey for distribution water facilities Survey for small scale water supply systems in Babeldaob Island Survey for financial status of PPUC IEE support	
24	15 July, 2014	Tue	Survey for distribution water facilities Survey for small scale water supply systems in Babeldaob Island Survey for financial status of PPUC IEE support	

No.	Day Month Year	Date	Activity	Remarks
25	16 July, 2014	Wed	Survey for KAWTP Survey for water quality analysis IEE support	
26	17 July, 2014	Thu	Survey for KAWTP Survey for water quality analysis Survey for small scale water supply systems in Babeldaob Island Survey for financial status of PPUC IEE support	
27	18 July, 2014	Fri	Survey for KAWTP Survey for Malakal water resources Survey for financial status of PPUC IEE support	
28	19 July, 2014	Sat	Analysis of collected data	
29	20 July, 2014	Sun	Analysis of collected data	
30	21 July, 2014	Mon	Survey for Airai service tank Survey for booster pump station IEE support Meeting with EQPB Departure from Koror / Arrival at Tokyo of consultant members (Mr. SHIMOOSAKO, Mr. KASUYA)	UA158 Koror・Guam UA828 Guam・Narita
31	22 July, 2014	Tue	Internal meeting (phone conference) Survey for leakage history Survey for analysis of distribution pipe network Survey for procurement condition Departure from Koror / Arrival at Tokyo of consultant members (Mr. KAGAWA)	UA158 Koror・Guam UA828 Guam・Narita
32	23 July, 2014	Wed	Survey for KAWTP Survey for leakage history Survey for analysis of distribution pipe network Survey for procurement condition Departure from Koror / Arrival at Tokyo of consultant members (Mr. FUJII)	UA827 Narita・Guam UA157 Guam・Koror
33	24 July, 2014	Thu	Survey for KAWTP Follow-up for organization and financial status of PPUC Survey for construction / procurement condition	
34	25 July, 2014	Fri	Survey for KAWTP Follow-up for organization and financial status of PPUC Survey for construction / procurement condition	
35	26 July, 2014	Sat	Analysis of collected data	
36	27 July, 2014	Sun	Analysis of collected data	
37	28 July, 2014	Mon	Survey for KAWTP Follow-up for organization and financial status of PPUC Survey for construction / procurement condition	
38	29 July, 2014	Tue	Supplement survey for facilities condition Survey for disposal method of Asbestos pipes Follow-up for organization and financial status of PPUC Survey for construction / procurement condition	
39	30 July, 2014	Wed	Survey for confirmation of position of pipeline Survey for confirmation of capacity evaluation Meeting with PPUC for technical points to be confirmed	
40	31 July, 2014	Thu	Supplement survey for facilities condition Survey for confirmation of capacity evaluation Preparation of Sector development framework	
41	1 Aug, 2014	Fri	Supplement survey for facilities condition Preparation of Sector development framework Departure from Koror / Arrival at Tokyo of consultant members (Mr. IGARASHI, Mr. TSUNOJI)	UA158 Koror・Guam UA828 Guam・Narita
42	2 Aug, 2014	Sat	Analysis of collected data	
43	3 Aug, 2014	Sun	Analysis of collected data	
44	4 Aug, 2014	Mon	Meeting with PPUC for Sector development framework Preparatory survey for second filed survey	
45	5 Aug, 2014	Tue	Meeting with PPUC for Sector development framework Report to JICA Palau office	
46	6 Aug, 2014	Wed	Departure from Koror / Arrival at Tokyo of consultant members (Mr. FUJII, Mr. SENO, Mr. SHIRAISHI)	UA158 Koror・Guam UA828Guam・Narita

（Second Field Survey ）

No.	Day Month Year	Date	Activity	Remarks
1	13 Sep, 2014	Sat	Departure from Tokyo / Arrival at Koror of consultant members (Mr. SENO, Mr. KASUYA)	UA827 Narita･Guam UA185 Guam･Koror
2	14 Sep, 2014	Sun	Analysis of collected data Inspection of measuring equipment	
3	15 Sep, 2014	Mon	Preparation of sub-contract works Survey for approval and authorization for Test pit survey, Topographic survey and Soil investigation.	
4	16 Sep, 2014	Tue	Preparation of sub-contract works Survey for route of transmission water main and pavement work Survey for removal of existing Malakal service tank	
5	17 Sep, 2014	Wed	Preparation of sub-contract works Meeting with BPW for decision of test pit point	
6	18 Sep, 2014	Thu	Preparation of sub-contract works Meeting with BPW for provision of as-build drawings of main road and Causeway Survey for structure of new service tank Survey for connection point with KB bridge	
7	19 Sep, 2014	Fri	Preparation of sub-contract works Meeting with BPW for pavement work after Test pit survey. Meeting with governor of Koror-Airai State	
8	20 Sep, 2014	Sat	Analysis of collected data	
9	21 Sep, 2014	Sun	Preparation of tender works for sub-contract Departure from Tokyo / Arrival at Koror of consultant members (Mr. FUJII, Mr. KAGAWA, Mr. TSUNOJI)	UA827 Narita･Guam UA157 Guam･Koror
10	22 Sep, 2014	Mon	Opening of tender document and confirmation of estimate Meeting with JICA Palau office	
11	23 Sep, 2014	Tue	Confirmation of estimate and contract negotiation Explanation of sector development framework	
12	24 Sep, 2014	Wed	Confirmation of estimate and contract negotiation Explanation of sector development framework Explanation of project components (draft)	
13	25 Sep, 2014	Thu	Confirmation of estimate and contract negotiation Explanation of project components (draft) Survey for pavement of road Departure from Tokyo / Arrival at Koror of consultant members (Mr. SHIRAISHI)	UA827 Narita･Guam UA157 Guam･Koror
14	26 Sep, 2014	Fri	Confirmation of estimate and contract negotiation Survey for pavement of road Explanation to Embassy of Japan	
15	27 Sep, 2014	Sat	Analysis of collected data	
16	28 Sep, 2014	Sun	Analysis of collected data Confirmation of route for leak detection	
17	29 Sep, 2014	Mon	Preparation of leak detection Preparation of measurement of flow meter Preparation of contract with sub-contractor	
18	30 Sep, 2014	Tue	Implementation of leak detection Discussion for re-arrangement of distribution zone Confirmation of position of undersea pipeline Survey for re-pavement of road Preparation of contract with sub-contractor	
19	1 Oct, 2014	Wed	Implementation of leak detection Finalization of Sector development framework Preparation of Technical Notes	
20	2 Oct, 2014	Thu	Implementation of leak detection Implementation of measurement of flow rate (KATWP) Confirmation of Test Pit points Signing on contract for sub-contractor	
21	3 Oct, 2014	Fri	Implementation of leak detection Commencement of Natural condition survey and Social condition survey Survey for route of transmission water main and distribution water pipeline. Confirmation of position of Malakal service tank Implementation of measurement of flow rate (KATWP) Departure from Tokyo / Arrival at Koror of consultant members (Mr. ISHIZUKA)	UA827 Narita･Guam UA157 Guam･Koror
22	4 Oct, 2014	Sat	Analysis of collected data Implementation of measurement of flow rate (KATWP)	
23	5 Oct, 2014	Sun	Analysis of collected data Implementation of measurement of flow rate (KATWP)	
24	6 Oct, 2014	Mon	Implementation of leak detection Survey for Natural conditions and Social conditions Confirmation of position of boring for soil investigation Meeting with PPUC for sharing issues of survey Departure from Tokyo of JICA officials (Ms. TAMURA）	UA874 Narita･Guam
25	7 Oct, 2014	Tue	Implementation of leak detection Survey for Natural conditions and Social conditions Meeting with PPUC for sharing issues of survey Arrival at Koror of JICA officials(Ms. TAMURA）	UA193 Guam･Koror
26	8 Oct, 2014	Wed	Implementation of leak detection Survey for Natural conditions and Social conditions Discussion on the minutes Survey for alternative land for Malakal service tank Departure from Tokyo / Arrival at Koror of consultant members (Mr. IGARASHI)	UA827 Narita･Guam UA157 Guam･Koror
27	9 Oct, 2014	Thu	Implementation of leak detection Survey for Natural conditions and Social conditions Discussion on the minutes / Signing on the M/D Discussion with ADB Report to Embassy of Japan Report to JICA Palau office Implementation of measurement of flow rate (Ngermid service tank)	

No.	Day Month Year	Date	Activity	Remarks
28	10 Oct, 2014	Fri	Implementation of leak detection Survey for Natural conditions and Social conditions Meeting for confirmation of technical specification Implementation of measurement of flow rate (Ngermid service tank / Ngerkesoaol service tank) Departure from Koror / Arrival at Tokyo of JICA officials (Ms. TAMURA）	UA158 Koror･Guam UA828 Guam･Narita
29	11 Oct, 2014	Sat	Analysis of collected data Survey for route of transmission water main and distribution water pipeline Implementation of measurement of flow rate (Ngerkesoaol service tank)	
30	12 Oct, 2014	Sun	Analysis of collected data Survey for route of transmission water main and distribution water pipeline Departure from Koror / Arrival at Tokyo of consultant members (Mr. SENO, Mr. KASUYA）	UA186 Koror･Guam UA828 Guam･Narita
31	13 Oct, 2014	Mon	Survey for Natural conditions and Social conditions Implementation of measurement of flow rate (Airai service tank) Confirmation of budget of PPUC Confirmation of accident of undersea pipeline Survey for route of transmission water main and distribution water pipeline	
32	14 Oct, 2014	Tue	Survey for Natural conditions and Social conditions Implementation of measurement of flow rate (Airai service tank / Arakabesang service tank) Coordination of meeting with Koror state government Survey for route of transmission water main and distribution water pipeline	
33	15 Oct, 2014	Wed	Survey for Natural conditions and Social conditions Implementation of measurement of flow rate (Arakabesang service tank / Ngerkesoaol service tank) Coordination of meeting with Koror state government Survey for route of transmission water main and distribution water pipeline	
34	16 Oct, 2014	Thu	Survey for Natural conditions and Social conditions Implementation of measurement of flow rate (Ngerkesoaol service tank) Coordination of meeting with Koror state government Application of environmental permission for soil investigation Survey for route of transmission water main and distribution water pipeline Survey for water supply pressure	
35	17 Oct, 2014	Fri	Survey for Natural conditions and Social conditions Coordination of meeting with Koror state government Meeting for installation method of transmission water main on KB bridge Survey for route of transmission water main and distribution water pipeline Report to Embassy of Japan	

No.	Day Month Year	Date	Activity	Remarks
36	18 Oct, 2014	Sat	Survey for route of transmission water main and distribution water pipeline Survey for service tank site Analysis of collected data	
37	19 Oct, 2014	Sun	Survey for route of transmission water main and distribution water pipeline Survey for service tank site Analysis of collected data	
38	20 Oct, 2014	Mon	Survey for Natural conditions and Social conditions Coordination of meeting with Koror state government Survey for design of transmission water main and distribution water pipeline Departure from Koror / Arrival at Tokyo of consultant members (Mr. FUJII, Mr. KAGAWA, Mr. TSUNOJI）	UA158 Koror･Guam UA828 Guam･Narita
39	21 Oct, 2014	Tue	Survey for Natural conditions and Social conditions Coordination of meeting with Koror state government Survey for design of transmission water main and distribution water pipeline	
40	22 Oct, 2014	Wed	Survey for Natural conditions and Social conditions Coordination of meeting with Koror state government Meeting with BPW and CIP for road pavement Survey for route of transmission water main and distribution water pipeline	
41	23 Oct, 2014	Thu	Survey for Natural conditions and Social conditions Technical meeting with PPUC Survey for route of transmission water main and distribution water pipeline Confirmation of progress of sub-contractor works	
42	24 Oct, 2014	Fri	Survey for Natural conditions and Social conditions Analysis of collected data Departure from Koror / Arrival at Tokyo of consultant members (Mr. SHIRAISHI, Mr. ISHIZUKA)	UA158 Koror･Guam UA828 Guam･Narita
43	25 Oct, 2014	Sat	Analysis of collected data	
44	26 Oct, 2014	Sun	Analysis of collected data	
45	27 Oct, 2014	Mon	Survey for Natural conditions and Social conditions Coordination of meeting with Koror state government Survey for route of transmission water main and distribution water pipeline Survey for service tank site	
46	28 Oct, 2014	Tue	Survey for Natural conditions and Social conditions Coordination of meeting with Koror state government Survey for route of transmission water main and distribution water pipeline Survey for service tank site	
47	29 Oct, 2014	Wed	Survey for Natural conditions and Social conditions Meeting with Koror state government for re-pavement Survey for route of transmission water	
48	30 Oct, 2014	Thu	Survey for Natural conditions and Social conditions Coordination of meeting with Koror state government Survey for route of transmission water main Survey for service tank site	

No.	Day Month Year	Date	Activity	Remarks
49	31 Oct, 2014	Fri	Survey for Natural conditions and Social conditions Discussion with PPUC on Technical Notes / signing Internal meeting Meeting for design / cost estimate of construction Survey for route of transmission water main Discussion of leakage accident of under KB bridge	
50	1 Nov, 2014	Sat	Analysis of collected data	
51	2 Nov, 2014	Sun	Analysis of collected data	
52	3 Nov, 2014	Mon	Survey for Natural conditions and Social conditions Coordination of meeting with Koror state government Confirmation of progress of sub-contractor works	
53	4 Nov, 2014	Tue	Survey for Natural conditions and Social conditions Survey for service tank site Survey for route of transmission water main	
54	5 Nov, 2014	Wed	Survey for Natural conditions and Social conditions Survey for service tank site Confirmation of progress of sub-contractor works Report to Embassy of Japan Report to JICA Palau office	
55	6 Nov, 2014	Thu	Departure from Koror / Arrival at Tokyo of consultant members (Mr. IGARASHI)	UA158 Koror･Guam UA828 Guam･Narita

（Draft Final Explanation）

No.	Day Month Year	Date	Activity	Remarks
1	19 Feb, 2015	Thu	Departure from Koror / Arrival at Tokyo of consultant members (Mr. IGARASHI, Mr. SHIRAISHI）	UA827 Narita･Guam UA157 Guam･Koror
2	20 Feb, 2015	Fri	Confirmation of current situation of transmission water main on KB bridge Discussion on Land acquisition for Malakal service tank	
3	21 Feb, 2015	Sat	Analysis of collected data	
4	22 Feb, 2015	Sun	Departure from Koror / Arrival at Tokyo of consultant members (Mr. FUJII）	UA827 Narita･Guam UA157 Guam･Koror
5	23 Feb, 2015	Mon	Explanation and discussion on Draft Final Report	
6	24 Feb, 2015	Tue	Departure from Tokyo / Arrival at Koror of JICA officials (Mr. OMURA, Mr. HASHIMOTO） Explanation and discussion on Draft Final Report Discussion on the cost of undertakings by the Samoan side and the implementation schedule (discussion with KSPLA)	UA827 Narita･Guam UA193 Guam･Koror
7	25 Feb, 2015	Wed	Kick off meeting (PPUC, MPIIC, Koror state, and EQPB) Explanation and discussion on Draft Final Report Discussion on the cost of undertakings by the Samoan side and the implementation schedule	
8	26 Feb, 2015	Thu	Discussion on the minutes	
9	27 Feb, 2015	Fri	Signing on M/D	
10	28 Feb, 2015	Sat	Departure from Koror / Arrival at Tokyo of JICA officials (Mr. OMURA, Mr. HASHIMOTO） Departure from Koror / Arrival at Tokyo of consultant members (Mr. FUJII, Mr. IGARASHI, Mr. SHIRAISHI)	UA192 Koror･Guam UA196 Guam･Narita

Appendix-3

List of Parties Concerned in the Recipient Country

List of Parties Concerned in Recipient Country

Agency / Name	Position
Palau Public Utilities Corporation (PPUC)	
Fritz Koshiba	Chairman （Administration is lasted by Sep, 2014）
Sam Yoyo Msang	Chairman （Administration is started from Oct, 2014）
Kione J. Isechal	Chief Executive Officer
Nicholas Kloulubak	Board member
David Dengokl	Acting Manager, Water and Wastewater Operation Division
Tmetuchl Baules	Administrative Director
Clarissa Adelbai	Administrative Grants Manager
Anthony Rudimch	Engineer, Water and Wastewater Operation Division
Richard Basma	Engineer, Water and Wastewater Operation Division
Lester Rehuher	Leak Detect Field Technician, Water and Wastewater Operation Division
John kintaro, Jr.	Project Coordinator
Hashinta Idechong	Accounting Manager, Accounting & Finance Division
Grant Ngirengechui	Administrative Supervisor
Irvin Tesei	Acting Manager of Water Connection
Ministry of Finance	
Kyonori Tellames	Senior Planning Analyst
Muriell Sinsak	Senior Planning Analyst
Ministry of Public Infrastructure, Industry and Commerce (MPIIC)	
Charles I. Obichang	Minister
Brian Dengokl	Director
Bureau of Public Works (BPW)	
Isaias Oiterong	Director
Brian Melairei	Manager
Calvin Ikesiil	Manager
Palau Visitors Authority (PVA)	
Nanae Singeo	Managing Director
Kadoi Ruluked	Marketing & Research Manager
Environmental Quality Protection Board (EQPB)	
Roxanne Y. Blesam	Executive Officer
Metiek Kimie Ngirchechol	Supervisor
Lynna Thomas	Compliance Specialist
Capital Improvement Program (CIP)	
Benjamin R. Asuncion	Senior Project Manager
Koror State Office	
Yoshitaka Adachi	Governor
Koror State, Building & Zoning Office	
Maggy Antonio	Executive Officer
Koror State Public Land Authority	
Laurinda Mariur	Chairman
Vera Dilsils Kanai	Executive Director
Airai State Planning and Development Commission	
Henry T Goto	Airai State Planning Development Officer
Asian Development Bank（ADB）	
Alfonsa Koshiba	-
Embassy of Japan	
Kazuhiro Tajiri	Ambassador Extraordinary and Plenipotentiary
Takao Anzawa	Counsellor
Eriko Nakanishi	Special Assistant
JICA Palau Office	
Nobuaki Matsui	Resident Representative
Takahisa Watanabe	Project Formulation Advisor

Appendix-4

Minutes of Discussions

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY
FOR
THE WATER SUPPLY SYSTEM IMPROVEMENT PROJECT
IN THE REPUBLIC OF PALAU

In response to the request from the Government of the Republic of Palau (hereinafter referred to as "Palau"), the Government of Japan decided to conduct a Preparatory Survey on the Water Supply System Improvement Project (hereinafter referred to as "the Project") and entrusted the survey to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA dispatched to Palau the Preparatory Survey Team (hereinafter referred to as "the Survey Team"), which is headed by Ms. Eriko Tamura, Director, Water Resources Management Division 1, Water Resources and Disaster Management Group, Global Environment Department, JICA, and is scheduled to stay in the country from 23 June 2014 to 27 June 2014.

The Survey Team held the discussions with the officials concerned of Palau. In the series of discussions and field surveys, both sides confirmed the items described in attached sheets. The Survey Team will proceed to further work and prepare the Preparatory Survey Report.

Koror, 27 June 2014

Eriko Tamura
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Charles I. Obichang
Minister
Ministry of Public Infrastructure,
Industries and Commerce

Fritz Koshiba
Chairman
Palau Public Utility Corporation

AP-4-1

ATTACHMENT

1. Tentative Title of the Project

The tentative title of the Project is "The Water Supply System Improvement Project". The title will be finalized at the later stage.

2. Objective of the Project

The objective of the Project is to improve the access to safe water in Koror State and Airai State through the rehabilitation and improvement of water supply system.

3. Responsible and Implementing Agency

3-1) The Responsible Agency is the Ministry of Public Infrastructure, Industries and Commerce (hereinafter referred to as "MPIIC").

3-2) The Implementing Agency is the Palau Public Utility Corporation (hereinafter referred to as "PPUC").

3-3) The organization chart of MPIIC and PPUC is attached as **Annex-1**.

4. Target Areas of the Preparatory Survey

The target areas of the preparatory survey are Koror State and Airai State.

5. Items requested by Palau

5-1) The original request for Japan's Grant Aid Scheme from the Palauan side are defined as below.

Malakal Water Tank	Item
Facilities	Filtration system for Malakal spring water
	Sandblasting and painting of water tank
	Piping to and from the tank
	Booster pump to the tank
	Road pavement restoration
Equipment	Tank level indicators
Soft (Non-physical) components	Tank analysis & Hydraulic analysis of wells
Design/Supervision	Design

Downtown Service Line Bypass	Item
Facilities	New piping to replace asbestos-cement pipes
Equipment	Pipe locator and leak detection equipment
Soft (Non-physical) components	None
Design/Supervision	None

Alternative Water Source	Item
Facilities	Rehabilitation of existing boreholes and development of new wells
Equipment	Well drilling equipment and training
Soft (Non-physical) components	None
Design/Supervision	Analysis and design

5-2) During the meeting, the Palauan side explained their strong concerns for the following items:
(a) Small-scale water supply systems in Babeldaob Island
(b) Alternative water source(s) in Palau especially in Airai State

5-3) The both sides agreed that the small-scale water supply systems in Babeldaob Island are not included in the Project, by considering efficiency and effectiveness, however the Sector Development Framework will cover them so that the Palauan side will be able to consider measures to be taken in the future.

5-4) As it is necessary to figure out the project priorities based on the urgency and appropriateness of the Japan's Grant Aid Scheme, the both sides agreed that the project components should be of water supply system for Koror State and Airai State. The tentative project components will be presented in the Sector Development Framework, which will be drafted in the 1st field survey in Palau.

6. Japan's Grant Aid Scheme

6-1) The Palauan side understood the Japan's Grant Aid Scheme explained by the Survey Team, as described in **Annex-2**.
6-2) The Palauan side shall take necessary measures, as described in **Annex-3**, for smooth implementation of the Project, as a condition for the Japanese Grant Aid.

7. Schedule of the Preparatory Survey

7-1) The consultant members of the Survey Team will conduct the 1st field survey in Palau until 6 August 2014 to draft tentative Sector Development Framework.
7-2) The consultant members of the Survey Team will conduct the 2nd field survey in Palau and draft Outline Design (hereinafter referred to as "OD") of the Project from September to October 2014.
7-3) JICA will prepare the draft preparatory survey report in English and dispatch a mission in order to explain its contents to the Palauan side around February 2015.
7-4) In case that the contents of the report are accepted in principle by the Palauan side, JICA will finalize the report and send it to the Palauan side around April 2015.
7-5) The Palauan side understands that execution of the preparatory survey does not necessarily imply the Japanese Government's commitment to the project implementation.

8. Other Relevant Issues

8-1) Framework of the Survey

As the original request for Japan's Grant Aid Scheme from the Palauan side were broad and the priority of the candidate projects was not identified, it is essential to decide the priority based on the urgency and appropriateness for the Japan's Grant Aid Scheme. In order to overview the water sector, then to define the scope and the component of the Project, the Survey Team will conduct a field survey to draft Sector Development Framework.

The both sides confirmed that the survey for the Sector Development Framework will be conducted in the 1st field survey in Palau. Through the Analytical work in Japan subject to the 1st field survey in Palau, the project scope and components shall be finalized. The OD shall be conducted through the 2nd field survey.

8-2) Sector Development Framework

The both sides agreed that Sector Development Framework includes the analysis of water supply system and sewerage system in Koror State and Airai State. It shall be compiled by the analysis of the existing data, site survey and interview to stakeholders in the 1st field survey, while the detailed analysis such as cost estimate, topographical survey and the formulation of the detail implementation schedule will not be covered. Effects by climate change shall be also stated in Sector Development Framework.

The draft table of contents of Sector Development Framework report is attached as **Annex 4**.

8-3) Importance of Sustainability

The both sides agreed that the project component should be elaborated considering financial and operational sustainability and resources of PPUC. For sustainable services providing safe and enough water at affordable level, PPUC's efforts are expected such as securing necessary budget, generating revenue, appropriate operation and maintenance of the existing facilities and reducing non-revenue water.

8-4) Basic Assessment of Sewerage System

The both sides confirmed that the Project shall focus on the water supply system while the sewerage system shall be excluded from the scope of the Project. However, the Survey Team proposed to conduct assessment of sewerage system as part of Sector Development Framework in order that the Palauan side utilizes it to consider further development plan. The Palauan side accepted this proposal.

8-5) Environmental and Social Considerations

(a) The both sides confirmed that the Survey Team would assist the Palauan side to conduct the Initial Environmental Examination (IEE) for the Project under the laws and regulations of Palau.

(b) The Palauan side explained the procedure and the necessary time frame of land acquisition. The Palauan side assured taking all necessary measures in case the Project requires land acquisition.

(c) The Survey Team explained that the environmental and social considerations studies would be conducted according to JICA's Guidelines for Environmental and Social Considerations in order to examine the mitigation measures of impacts and monitoring plan during/after the project implementation.

8-6) Budget for Operation and Maintenance

The Survey Team requested the Palauan side to share the financial statement of past 3 years and the latest budget plan to confirm whether PPUC can secure the budget for operation and maintenance. The Palauan side assured to share the requested documents and to secure budget allocation sufficient to maintain the Project equipment and facilities.

8-7) Counterpart Personnel

The Survey Team requested the Palauan side that necessary number of counterpart personnel shall be assigned to the Project and necessary arrangements with related

organizations be made during the Survey and implementing stage in Palau. The following four staffs are nominated as the counterpart personnel of the Project:

(a) Mr. David Dengokl, Acting Manager, Water and Wastewater Operation
(b) Mr. Anthony Rudimch, Water and Wastewater Operation
(c) Ms.Clarissa Adelbai, Grants Manager
(d) Mr.Richard Basiya, Water and Wastewater Operation

8-8) Customs Duties and Tax exemption

The taxes including Value Added Tax (VAT), customs duty, and any other taxes and levies in Palau which are to arise from the Project activities will be exempted by the Palauan side. PPUC will take any procedures necessary for the tax exemption with the Ministry of Finance of Palau on its responsibility.

8-9) Coordination with Other Projects

Both sides confirmed that the on-going / proposed projects by other development partners should be carefully investigated to avoid overlapping with the Project. The Palauan side agreed to provide necessary information on related projects.

8-10) Major Undertakings

Upon the Palauan side's request to clarify the item No.6 of Annex-3, the Japanese side explained that "all the expenses, other than those covered by the Grant" are such costs as personnel costs of the counterpart, their transport/communication expenses, administration procedures costs in Palau (for example, land acquisition and building permits).

(End)

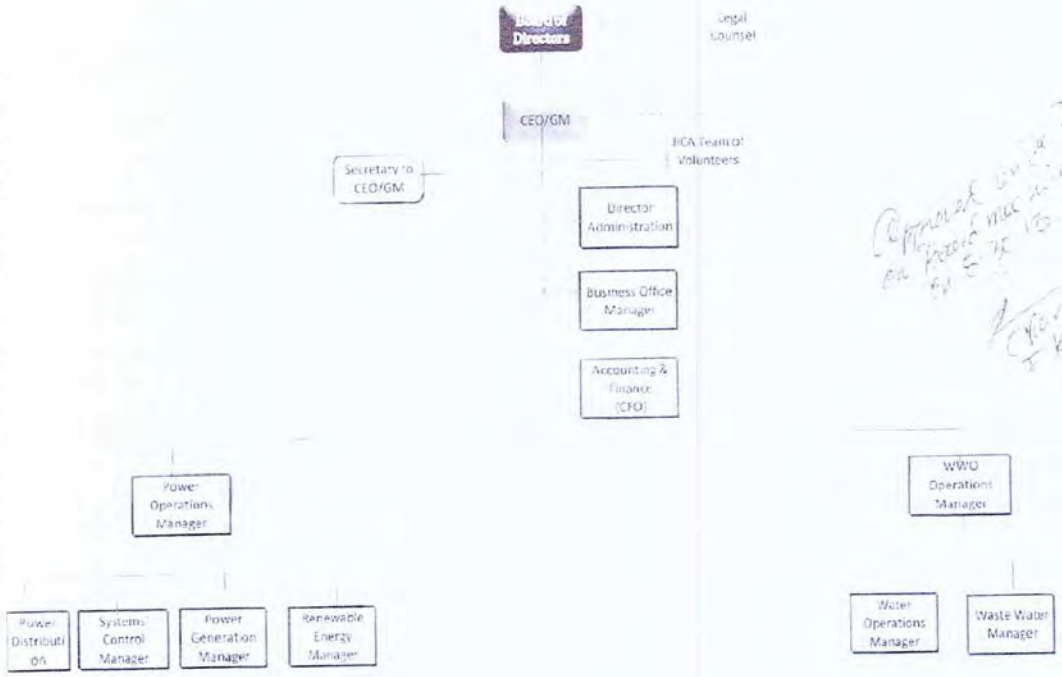


Figure 1-2: Organization Chart of Palau Public Utility Corporation

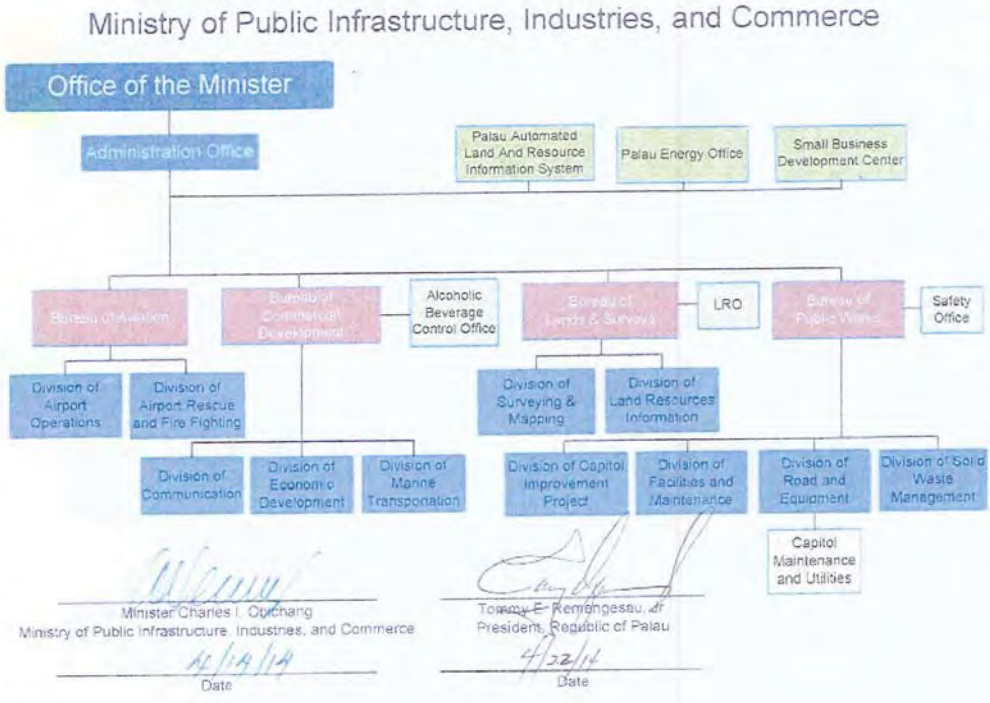


Figure 1-1: Organization Chart of Ministry of Public Infrastructure, Industries and Commerce

Annex-1: Organization Chart of MPIIC and PPUC

Annex-2: Japan's Grant Aid Scheme

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

- Preparatory Survey (hereinafter referred to as "the Survey")
  - the Survey conducted by JICA
- Appraisal & Approval
  - -Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - -The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - -Agreement concluded between JICA and a recipient country
- Implementation
  - -Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the

Project.

- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

AP-4-6

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex 3.

(6) Proper Use

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) Export and Re-export

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the

recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

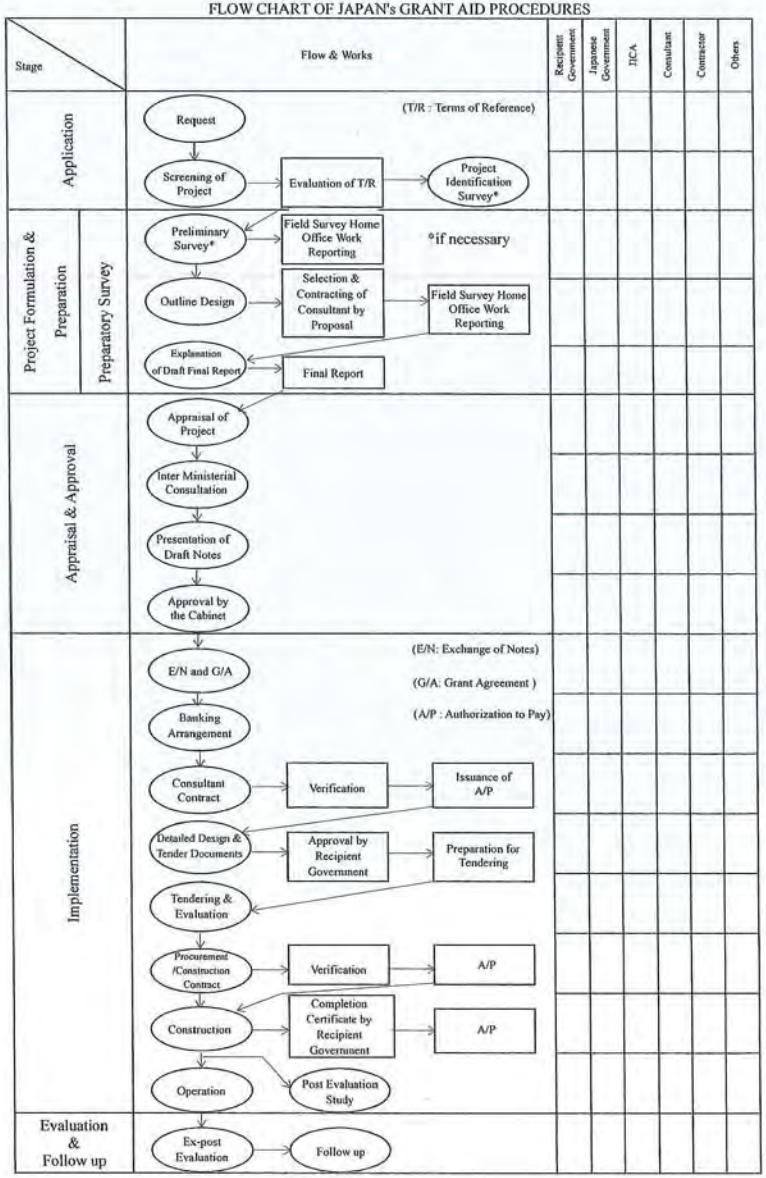
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

Attachment 1 for Annex-2

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



AP-4-7

Annex-3: Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure [a lot] / [lots] of land necessary for the implementation of the Project and to clear the [site] / [sites];		●
2	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Internal transportation from the port of disembarkation to the project site	(●)	(●)
3	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be borne by the Authority without using the Grant		●
4	To accord Japanese physical persons and / or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
5	To ensure that the facilities and the products be maintained and used properly and effectively for the implementation of the Project		●
6	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		●
7	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
8	To give due environmental and social consideration in the implementation of the Project.		●

(B/A: Banking Arrangement, A/P: Authorization to pay)

Annex-4: Draft Contents of Sector Development Framework

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY
FOR
THE WATER SUPPLY SYSTEM IMPROVEMENT PROJECT
IN THE REPUBLIC OF PALAU

In response to the request from the Government of the Republic of Palau (hereinafter referred to as "Palau"), the Japan International Cooperation Agency (hereinafter referred to as "JICA") decided to conduct a Preparatory Survey on the Water Supply System Improvement Project (hereinafter referred to as "the Project") with the consent of the Government of Japan.

JICA dispatched the Preparatory Survey Team (hereinafter referred to as "the Survey Team") to Palau, which is headed by Ms. Eriko Tamura, Director, Water Resources Management Team 1, Water Resources and Disaster Management Group, Global Environment Department, JICA. The Survey Team conducted the 1st Field Survey from 23 June 2014 to 27 June 2014 to discuss priority of the scope of the Project and draft contents of the Sector Development Framework. Based on the items agreed on the 1st Field Survey, the Survey Team held further discussions with the officials concerned of Palau (hereinafter referred to as "the Palauan side") from 8 October 2014 to 9 October 2014, to decide the contents of the Outline Design of the Project.

In the series of discussions, the Survey Team and the Palauan side (hereinafter referred to as "the both sides") confirmed the items described in attached sheets. The Survey Team will proceed to further work and prepare the Preparatory Survey Report.

Koror, 9 October 2014

Eriko Tamura
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Charles I. Obichang
Minister
Ministry of Public Infrastructure,
Industries and Commerce

Kione J. Isechal
Acting CEO
Palau Public Utilities Corporation

AP-4-9

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve the stability of water supply in Koror State and Airai State through the rehabilitation and improvement of water supply system, by improving the transmission main(s), replacing the distribution lines, and reforming the water distribution zones.

2. Responsible and Implementing Agency

2-1) The Responsible Agency is the Ministry of Public Infrastructure, Industries and Commerce (hereinafter referred to as "MPIIC").

2-2) The Implementing Agency is the Palau Public Utility Corporation (hereinafter referred to as "PPUC").

3. Project Site

The target areas of the preparatory survey are Koror State and Airai State.

4. Schedule of the Preparatory Survey

4-1) The 1st field survey in Palau was conducted from 23rd June to 6th August 2014 to draft tentative Sector Development Framework.

4-2) The consultant members of the Survey Team conducts the 2nd field survey in Palau and collect necessary information for Outline Design (hereinafter referred to as "OD") of the Project from 13th September to 6th November 2014.

4-3) JICA will prepare the draft preparatory survey report in English and dispatch a mission in order to explain its contents to the Palauan side around February 2015.

4-4) In case that the contents of the report are accepted in principle by the Palauan side, JICA will finalize the report and send it to the Palauan side around April 2015.

4-5) The Palauan side understands that execution of the preparatory survey does not necessarily imply the Japanese Government's commitment to the project implementation.

5. Main points discussed on the contents of the Sector Development Framework

5-1) Sector Development Framework

The Survey Team explained the contents of the Sector Development Framework (Draft Final) which includes the analysis of water supply system and sewerage system in Koror State and Airai State, capacity assessment of PPUC and the priority of the candidate

projects. The Survey Team emphasized the importance to enhance operation and maintenance of the facilities and equipment and recommended PPUC to utilize Sector Development Framework as the reference of PPUC's mid-term operational Plan.

The list of issues recommended for water supply sector in the Sector Development Framework report is attached as **Annex-1**, and PPUC agreed to follow the recommendation.

5-2) Basic Assessment of Sewerage System

The both sides confirmed that the Project shall focus on the water supply system while the sewerage system would be excluded from the scope of the Project. However, the Survey Team conducted the basic assessment of sewerage system as Chapter 4 of Sector Development Framework in order that the Palauan side utilizes it to consider further development plan.

The Survey Team explained that the basic assessment of sewerage system was carried out from June 23, 2014 to July 18, 2014.

The Survey Team emphasized that PPUC was expected to review the items described and continue activities supported by the past projects by their own initiatives. Strong commitment of PPUC is indispensable to consider new projects.

AP-4-10

5-3) Importance of leak detections and leak repairs in private plots

The Survey Team reported that numerous leaks are found in private plots after the customers' meters. The Survey Team emphasized that PPUC should struggle with the reduction of such leakage generated in the private plots as it should be the worthless water consumptions, even though such leakages are not categorized as non-revenue water.

The Survey Team also recommended that PPUC should facilitate leak detections, leak repairs in private plots by the customers at cost and water conservation activities such as campaign to be conducted, according to the Sector Development Framework.

5-4) Comments for the draft of Sector Development Framework

The Survey Team requested the Palauan side to send written comments regarding the Sector Development Framework to JICA, and the Palauan side replied to do it within 2 weeks if necessary.

6. Main points discussed on the scope of the Project

6-1) Scope of the Project

As the both sides confirmed on the Minutes of Discussion of the 1st Field Survey, paragraph 2 in 8. 8-1, dated 27 June 2014, the scope of the project was considered based on the request from Palauan Side, urgency and the appropriateness for Japan's Grant Aid Scheme as described in Sector Development Framework.

Based on its considerations, in order to achieve the objective of the Project described above, the both sides confirmed that following components had the high priority and to be covered in the Project. The conceptual diagram of each component is attached as **Annex-2**.

Priority	Issues	Components of the Project	Expected Output
1	The current water production reaches 4MG/d. However, the exiting transmission main was designed for 2.1MG/d. The current water flow exceeds the assured level by design. If no pipeline improvement is provided, much higher capacity is necessary for transmission pumps.	Installation of additional water transmission main from Koro- Airai Water Treatment Plant to Ngerkesoaol Distribution tank	Not to increase the required energy for water transmission and to escape from higher transmission pressure (risk of pipeline burst)
2	Water transmission and distribution is inefficient in energy. Ngerkesoaol Service Zone suffers from inappropriate water pressure especially for higher areas in altitude and far area from distribution tank such as Malakal area.	Rearrangement of distribution zones including the establishment of the Malakal distribution zone	To maintain appropriate water pressure To reduce worthless input for energy for water transmission and distribution
3	Estimated NRW ratio is high at 48%. Much leakage is estimated as a main cause of NRW.	Replacement of major distribution lines including the replacement of existing Asbestos Cement(AC) pipes and installation of new Polyvinyl Chloride (PVC) Pipe	Reduction of NRW Reduction of the cost for energy consumption of transmission pumps.

The Outline Design for each component shall be conducted in the 2nd Field Survey and 2nd analysis in Japan.

6-2) Target Year

The target year of the Project is basically set up as the year 2020, which is shortly after the completion of the Project, because Japan's grant aid aims to meet the urgent and immediate needs in the Project area.

6-3) Importance of Sustainability

The both sides agreed that the project component was elaborated considering financial and operational sustainability and resources of PPUC. For sustainable and stable services providing safe and enough water at affordable level, PPUC's efforts are expected such as securing necessary budget, generating revenue, developing human resources, operating and maintaining the existing facilities appropriately, and reducing non-revenue water.

6-4) Utilization of planned pipeline of KB Bridge

The Survey Team explained that, to cross the KB Channel, it was recommended to utilize the planned bridge-attached pipeline, of which construction work is under tendering procedures by the Palauan side to connect new transmission main, but due to financial constraints, the project is on hold.

The Palauan side accepted the recommendation and assured to consider connecting methods to the new transmission main during the 2nd Field Survey. The Palauan side also confirmed to continue their effort to secure funding and to complete the installation of the planned bridge-attached pipeline before the Project starts. The Survey Team will propose the design which the new transmission main will be able to connect with both the existing pipeline and the planned bridge-attached pipeline.

6-5) Existing AC pipes

The both sides confirmed that the existing AC pipes, which may be abandoned, shall be left underground as it is and disposal of old AC pipes should not be included in the scope of the Project. If necessary to be taken out (cut off) for some portions of the pipelines, the Palauan side assured that PPUC shall dispose it according to the relevant regulations and laws of Palau.

The Survey Team recommended that PPUC should continue the scheduled replacement for old AC pipelines, even after the Project, in accordance with the Sector Development Framework.

6-6) Installation of service feeders

The both sides confirmed that, when laying the new water distribution pipelines, installation of service feeders (lateral connections) up to the existing water meters (customer's meters) shall be included in the Project while the meters are not provided.

The both sides also confirmed the following:

(a) The Japanese side will lay the service feeders up to edges of road. The feeders' location should be closed to the existing ones as much as possible.
(b) The Palauan side should assist the Japanese contractor at sites to find the existing service feeders, providing PPUC's staff-members.
(c) After the Japanese laying work of the service feeders, the Palauan side should connect them to existing meters or new feeders to be newly laid along the project by PPUC.
(d) The connection switching works shall be covered by PPUC and it should be promptly conducted after completion of the replacement of water distribution pipelines.

6-7) Restoration of paving

The Survey Team explained that, with regard to the restoration work of road paving caused by the proposed pipe-laying works, the scope of the works in the Project shall be in compliance with the laws and regulations of Palau. The Survey Team requested the Palauan side to arrange the meeting with relevant authorities such as the Ministry of Public Infrastructure, Industry and Commerce, Koror State and Airai State to discuss the detailed plan of the paving works including construction procedures and cost demarcation.

The Palauan side assured that PPUC shall make all necessary arrangements.

7. Main points discussed on the undertakings of PPUC for the Project implementation

7-1) Preparation of land for the new Malakal Distribution Tank

The both sides confirmed that PPUC had all responsibility to secure the land for the planned Malakal distribution tank and clear the land before construction. Besides, the Survey Team emphasized that the preparation of land for new Malakal distribution tank should be completed before the tendering process for the construction contract of the Project.

The Palauan side explained that PPUC shall acquire enough space of land for the new Malakal tank at the adjacent yard to the exiting one. The Palauan side further explained that the mentioned land belongs to the Koror State (a public land) and it would be permitted by the State for the land of water tank.

The both sides confirmed that the Palauan side shall submit a copy of permission issued by the Koror State for the land utilization, to JICA Palau Office by the end of October

2014.

7-2) Removal of Farming Land from the Site of Malakal Distribution Tank

The Survey Team emphasized that the Palauan side shall remove the existing farm lands and other obstacles such as farming stores, etc. in peaceful and amicable ways. The peaceful removal shall be completed before the end of April, 2015.

The Palauan side answered the following:

(a) The Koror State has been already aware of the issue and confirmed that the land belongs to the State.

(b) PPUC and the Koror State shall take necessary procedures for removal of the obstacles and clean the land before the the end of April, 2015.

7-3) Temporary Access Road to Malakal Distribution Tank

The Survey Team requested that the Palauan side should make gravel pavements on the existing access road to the planned Malakal Distribution Tank before commencement of tendering procedures for the Japanese Contractor. The Palauan side agreed on implementing the mentioned access road preparation. During the construction work, the contractor will maintain the access road.

AP-4-12

7-4) Undertakings of PPUC for the 2nd Field Survey

The both sides confirmed the following items so as to conduct the 2nd Field Survey smoothly.

- PPUC shall provide assistant staffs/guides and necessary permissions from road administrators and the Environmental Quality Protection Board (EQPB) for the leak detection surveys to secure prompt and safe activities, even if conducted in nighttime
- PPUC shall obtain necessary permissions for the site surveys for underground conditions (test pits), topography and soil conditions for pipeline routes and the sites for water distribution tanks.
- PPUC shall obtain the permissions and assist the Survey Team for smooth implementation of the social condition survey (interviews survey) for randomly selected residents.
- PPUC shall assist the Survey Team in metering works of water flows at treatment plant and water distribution tanks.
- PPUC shall assist the Survey Team in metering works of water distribution pressures in the networks.

8. Other relevant Issues

8-1) Environmental and Social Considerations

(a) The both sides confirmed that PPUC was responsible for taking any measures to complete the clearance process, in case that the relevant laws and regulations in Palau require any environmental and social considerations for implementing the Project.

(b) The both sides confirmed that the Survey Team would assist the Palauan side to conduct the Initial Environmental Examination (IEE) for the Project in order to examine the mitigation measures of impacts and monitoring plan during/after the project implementation.

(c) The environmental and social considerations process shall also follow the "JICA Guidelines for Environmental and Social Considerations"(April 2010).

(d) The Survey Team requested the Palauan side to submit Environmental Checklist and Environmental Monitoring Form at the time of the mission to explain the draft of preparatory survey report under the guidance of the Survey Team. The form of Environmental Checklist is attached as **Annex-3** and Environmental Monitoring Form is attached as **Annex-4**.

(e) The both sides confirmed that information on environmental and social considerations including major impacts and relevant mitigation measures would be summarized in the Environmental Checklist. The Palauan side confirmed they would inform JICA of any major changes which may affect environmental and social considerations made for the Project by revising the Checklist in a timely manner.

(f) The both sides confirmed that environmental monitoring would be conducted by PPUC in accordance with the Environmental Monitoring Plan described in the Preparatory Study Report.

(g) PPUC confirmed that the results of environmental monitoring would be provided to JICA as a part of Monthly Progress Report by filling in Environmental Monitoring Form until the completion of the project under the guidance of the Consultant contracted in the Project, provided that there is no outstanding issue regarding the environmental and social considerations during operation of the Project.

(h) In case JICA finds that there is a need for improvement in a situation with respect to environmental considerations after the agreed monitoring period, JICA may request to extend the period of monitoring and reporting until JICA confirms the issues have been properly addressed in accordance with the agreement between PPUC and JICA.

(i) The Survey Team requested PPUC to disclose the monitoring results to local project stakeholders, and PPUC agreed to disclose monitoring results on their website/in their

offices. PPUC agreed JICA's disclosure of provided monitoring results in the monitoring form on its website.

8-2) Customs Duties and Tax exemption

The taxes including Value Added Tax (VAT), customs duty, and any other taxes and levies in Palau which are to arise from the Project activities will be exempted by the Palauan side. PPUC will take any procedures necessary for the tax exemption with the Ministry of Finance of Palau on its responsibility.

8-3) Coordination with Other Projects

Both sides confirmed that the on-going / proposed projects by other development partners should be carefully investigated to avoid overlapping with the Project. The Palauan side agreed to provide necessary information on related projects.

8-4) Major Undertakings

Upon the Palauan side's request to clarify the item No.6 of **Annex-5**, the Japanese side explained that "all the expenses, other than those covered by the Grant" are such costs as personnel costs of the counterpart, their transport/communication expenses, administration procedures costs in Palau (for example, land acquisition and building permits).

(End)

AP-4-13

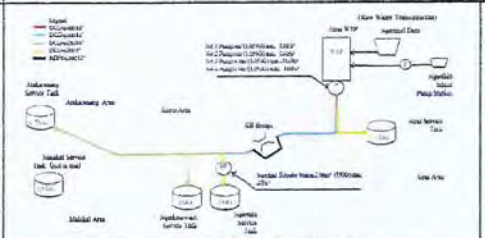
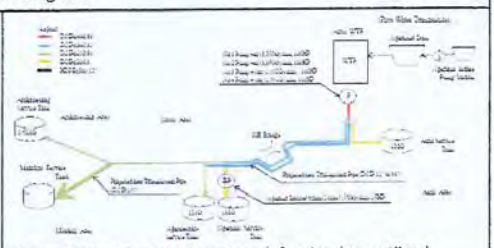
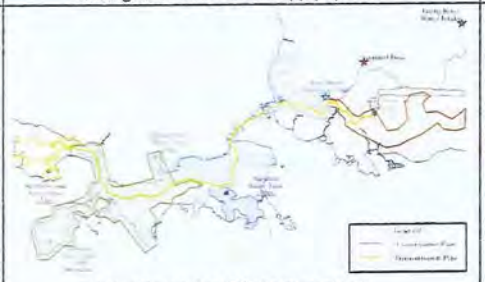
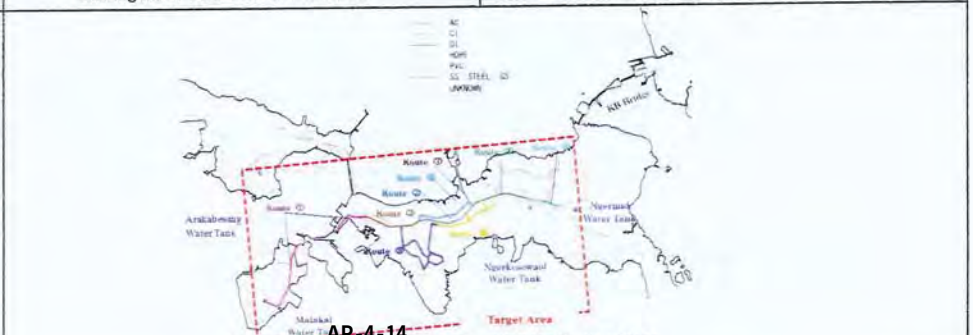
Annex-1: The list of issues recommended for water supply sector in the Sector Development Framework report

1. Summary of Capacity Assessment
2. Short and Medium Terms Target for Water Supply Development
3. Water Demand
4. Capacity of Water Source
5. Reduction of NRW
6. Stable Water Transmission and Distribution
7. Assurance for Water Quality
8. Recommendation for Urgent Action Plan
9. Meter Installation
10. Strengthening Transmission Main
11. Modification of Distribution Zones
12. Establishment of Malakal Zone and Transmission Main to Malakal Tank
13. Replacement of Major Distribution Lines
14. Soft Approach
15. Priority for Urgent Action Plans
16. Recommendation for Short / Medium Action Plan
17. Rehabilitation of Koror-Airai Water Treatment Plant (KAWTP)
18. Improvement of Ngerimel Dam
19. Improvement of Ngerikiil Intake Pump Station
20. Establishment of Airai Well Field
21. Painting the Existing Tanks
22. Improvement of Small Scale Water Supply System in Babeldaob
23. Replacement of Remained AC Pipeline
24. Soft Approach
25. Priority for Short / Medium Terms Action Plans

Environmental Checklist: 14. Water Supply (1)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) (b) (c) (d)	(a) (b) (c) (d)
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) (b)	(a) (b)
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)	(a)
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating measures taken? (b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	(a) (b)	(a) (b)
	(2) Water Quality	(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	(a)	(a)
	(3) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations?	(a)	(a)
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a)	(a)
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a)	(a)
3 Natural Environment	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a)	(a)

Annex-2: The conceptual diagram of each component

Priority	Components	Conceptual diagram
1	Installation of additional water transmission main from Koro- Airai Water Treatment Plant to Ngerkesoaol Distribution tank	 Existing Koror-Airai water supply system  Koror-Airai water supply system (after implementiing)
2	Rearrangement of distribution zones including the establishment of the Malakal distribution zone	 Existing Koror-Airai Distribution zones  Koror-Airai Distribution zones (after implementing)
3	Replacement of major distribution lines including the replacement of existing Asbestos Cement(AC) pipes and installation of new Polyvinyl Chloride (PVC) Pipe	 Route for Urgent Replacement for Old Distribution Pipes

Environmental Checklist: 14. Water Supply (3)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	(a) (b)	(a) (b)
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)	(a)
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)	(a)
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) (b)	(a) (b)
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) (b) (c) (d)	(a) (b) (c) (d)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) (b) (c) (d)	(a) (b) (c) (d)

Environmental Checklist: 14. Water Supply (2)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) (b) (c) (d)	(a) (b) (c) (d)
	(3) Hydrology	(a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows?	(a)	(a)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) (b) (c) (d) (e) (f) (g) (h) (i) (j)	(a) (b) (c) (d) (e) (f) (g) (h) (i) (j)

MONITORING FORM

-If environmental reviews indicate the need of monitoring by JICA, JICA undertakes monitoring for necessary items that are decided by environmental reviews. JICA undertakes monitoring based on regular reports including measured data submitted by the project proponent. When necessary, the project proponent should refer to the following monitoring form for submitting reports.

-When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

1. Responses/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period
ex.) Responses/Actions to Comments and Guidance from Government Authorities	

2. Mitigation Measures

- Air Quality (Emission Gas / Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
SO_2						
NO_2						
CO						
O_3						
Soot and dust						
SPM						
Dust						

- Water Quality (Effluent/Wastewater/Ambient Water Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH						
SS (Suspended Solid)						
BOD/COD						
DO						
Total Nitrogen						
Total Phosphorus						
Heavy Metals						
Hydrocarbons / Mineral Oils						
Phenols						
Cyanide						
Temperature						

Environmental Checklist: 14. Water Supply (4)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) (b) (c) (d)	(a) (b) (c) (d)
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked.	(a)	(a)
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a)	(a)

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

- Waste

Monitoring Item	Monitoring Results during Report Period

- Noise / Vibration

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise level						
Vibration level						

- Odor

Monitoring Item	Monitoring Results during Report Period

3. Natural Environment

- Ecosystem

Monitoring Item	Monitoring Results during Report Period
ex.) Negative effects/Actions to Valuable species	

4. Social Environment

- Resettlement

Monitoring Item	Monitoring Results during Report Period

- Living / Livelihood

Monitoring Item	Monitoring Results during Report Period

AP-4-17

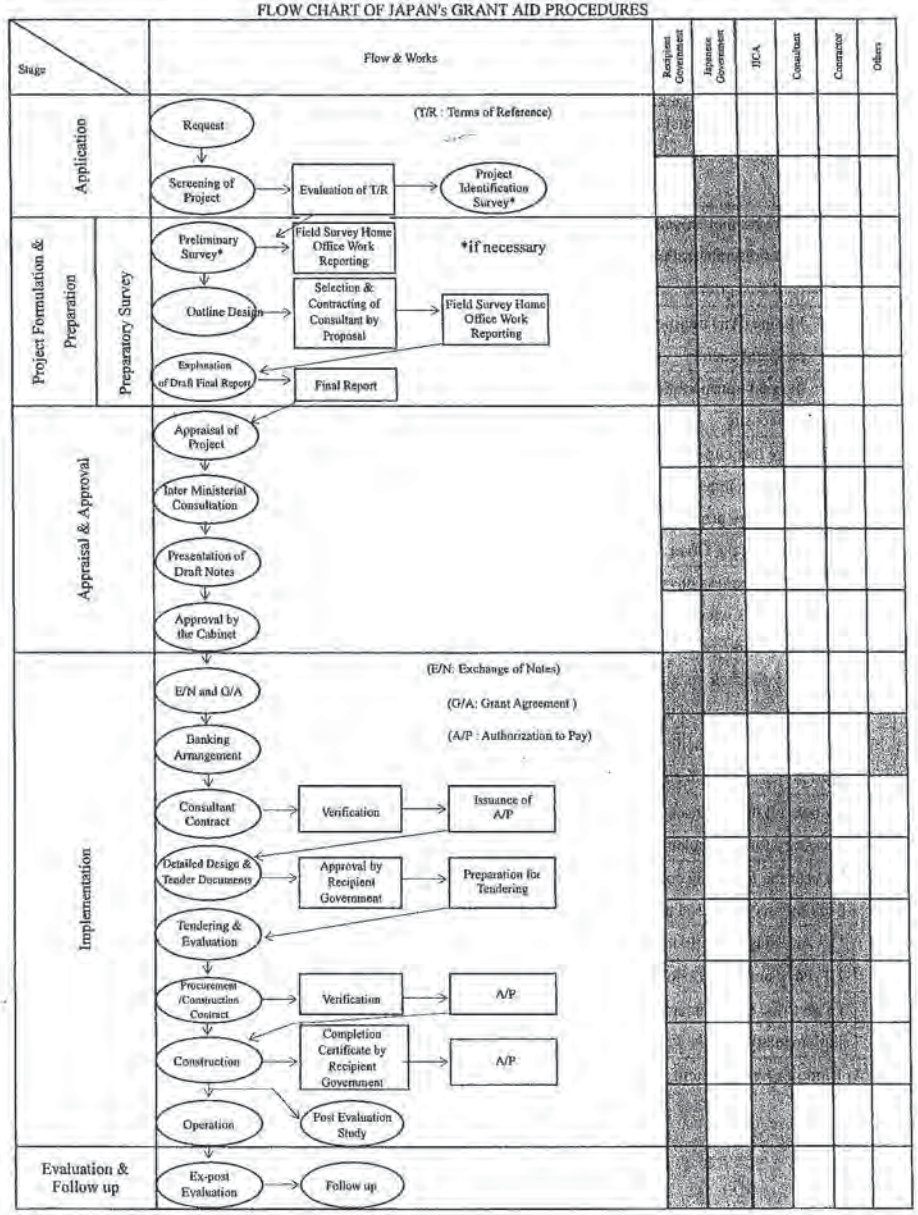
Annex-5: Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure [a lot] / [lots] of land necessary for the implementation of the Project and to clear the [site] / [sites];		●
2	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Internal transportation from the port of disembarkation to the project site	(●)	(●)
3	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be borne by the Authority without using the Grant		●
4	To accord Japanese physical persons and / or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
5	To ensure that the facilities and the products be maintained and used properly and effectively for the implementation of the Project		●
6	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		●
7	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
8	To give due environmental and social consideration in the implementation of the Project.		●

(B/A: Banking Arrangement, A/P: Authorization to pay)

Attachment 1 for Annex-5

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY FOR OUTLINE DESIGN SURVEY
FOR THE WATER SUPPLY SYSTEM IMPROVEMENT PROJECT
IN THE REPUBLIC OF PALAU
(EXPLANATION OF THE DRAFT FINAL REPORT)

In response to the request from the Government of the Republic of Palau (hereinafter referred to as "Palau"), the Japan International Cooperation Agency (hereinafter referred to as "JICA") decided to conduct a Preparatory Survey on the Water Supply System Improvement Project (hereinafter referred to as "the Project") with the consent of the Government of Japan. JICA has conducted the Preparatory Survey from June 2014 to October 2014. Afterward, JICA prepared a draft final report of the survey, based on discussions, field surveys, and technical examination of the results. In order to explain and consult with the officials concerned of Palau (hereinafter referred to as "the Palauan side") on the components of the draft final report, JICA dispatched the Draft Final Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Yoshiki Omura, Senior Advisor, JICA from 24 February 2015 to 28 February 2015.

As a result of discussions, the Team and the Palauan side (hereinafter referred to as "both sides") confirmed the items described in the attached sheets. The confirmed items will be preceded accordingly to formal procedures of the Palauan side and the Japanese side when the Project is accepted and approved by the both Governments.

Koror, 27 February 2015

Yoshiki Omura
Leader
Draft Final Report Explanation Team
Japan International Cooperation Agency

Charles I. Obichang
Minister
Ministry of Public Infrastructure
Industries and Commerce

Sam Yoyo Masang
Chairman
Palau Public Utilities Corporation

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve the stability of water supply in the central part of Koror State (Koror island, Malakal island and Arakabesang island) and Airai State (Babeldaob island) through the rehabilitation and improvement of the transmission main(s), reforming water distribution zones and replacing distribution mains.

2. Responsible and Implementing Agencies of the Project

2-1) The Responsible Agency is the Ministry of Public Infrastructure, Industries and Commerce (hereinafter referred to as "MPIIC").

2-2) The Implementing Agency is the Palau Public Utilities Corporation (hereinafter referred to as "PPUC").

3. Components of the Draft Final Report

The Palauan side agreed and accepted the components of the draft final report explained by the Team. The components are as described below. The Project sites map is shown in **Annex-1**.

3-1) Civil/Mechanical works

Items	Facilities
1. Improvement of Koror-Airai Water Transmission System	1-1 Installation of additional pipeline for transmission from KAWTP up to Ngerkesoul Service Tank ➢ L=3.24mi (5,186m), DCIP DN16in (400mm)
2. Improvement of Water Distribution Networks (Modification of Water Distribution Zones)	2-2 Installation of exclusive pipeline for transmission to Malakal Water Distribution Zone ➢ L=1.93mi (3,094m), DCIP DN10in (250mm)
	2-3 Modification of water distribution zones (Construction of Malakal service tank, installation of flowmeters for each service tank) ➢ service tank: 1 unit, Capacity: 0.25MG (950m³), RC-made, Rectangular ➢ Flowmeter: DN6-8in (150-200mm), 5 units
3. Improvement of Water Distribution Networks (Replacement of Water Distribution Main)	3-1 Replacement of deteriorated asbestos cement (AC) pipelines ➢ Water distribution Pipeline: L=8.08mi (12,920m) ➢ Lateral connection (to existing service pipe): 308 units, PVC DN2in (50mm)

Note: KAWTP is Koror - Airai Water Treatment Plant

3-2) Consulting services

a) Detailed design
b) Assistance for tendering
c) Construction supervision
d) Technical assistance (Soft component of the Project)

4. Submission of the Final Report

JICA will complete the final report in accordance with the confirmed items and send it to the Palauan side in May 2015.

5. Japan's Grant Aid Scheme

5-1) The Palauan side understood the Japan's Grant Aid Scheme explained by the Team, as described in **Attachment 1 for Annex-2**.

5-2) The Palauan side will take the necessary measures, as described in **Attachment 2 of Annex-2** for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Project Implementation Schedule

The Team explained to the Palauan side that the tentative implementation schedule was as attached in **Annex-3**.

7. Main points discussed on the issue of the Project component

7-1) Expected outcomes and Indicators

Both sides agreed that key indicators for expected outcomes were as follows. The Palauan side agreed that PPUC had responsibility to monitor the performance and report them to JICA, until 2020 annually.

[Quantitative Effect]

Indicator	Baseline (as of year 2013)	Target (3 years after the completion, planned as Year 2020)
Capacity of clear water transmission	2.1MGD (7,950m³/day)	4.0MGD (15,140m³/day)
Service Pressure in the Project area(*)	less than 2 psi (0.014MPa)	more than 20 psi (0.14MPa)

(*)Ngerbeched area, the lowest pressure area in the Project area shall be the monitoring area.

[Qualitative Effect]

- The service conditions in the central part of Koror State and Airai State is improved by achieving the stability of water supply through the Project.
- Leak detection activities and water distribution management become easier to conduct for PPUC by the rearrangement of distribution zones.

7-2) Measurements of Parameters for Quantitative Effects

Both sides confirmed that the following are parameters for quantitative effects:

a) Water production
b) Water service pressures in Ngerbeched

Water production data, such as production (total / maximum / minimum / average monthly / daily) will continue to be recorded for 24hours at Koror - Airai Water Treatment Plant (KAWTP).

Likewise water service pressures should be measured by PPUC periodically as follows:

c) Place: same as the baseline points at Ngerbeched: 1) Koror Capitol, 2) School, 3) House, 4) Chapel, 5) Belau National Museum.
d) Frequency: Once a month (the 1st Wednesday of every month)
e) Time for measurement: 7:00PM.

7-3) Utilization of planned pipeline of KB Bridge

The Minutes of Discussions dated 9 October 2014 described that the proposed

transmission pipeline would be designed to connect with the existing undersea pipeline and to have a branch for possible connection to the planned (then) bridge-attached pipeline.

Through the supplemental field survey, the Team found that there is about 250m (833ft) gap between the proposed connection point to the existing undersea pipeline and starting point of the bridge-attached pipeline in Airai side.

Considering the gap, the Team proposed to revise outline design of transmission pipeline to connect to the bridge-attached pipeline.

Both sides agreed above modification of outline design. The outline design would be revised based on the design document of PPUC.

The Palauan side assured that PPUC should provide as-built drawings for both connection points of Koror and Airai sides by the end of May 2015, in order to review the revised outline design.

The Palauan side explained the design, schedule and the current progress of the construction works and they stated that the material procurement has been commenced and the construction works are scheduled until the middle of July 2015.

7-4) Water level monitoring system for Malakal service tank

The Team explained that, based on the request of PPUC, a water level monitoring system would be installed to the Malakal service tank, likewise those installed for the other tanks in June 2014 by PPUC. Both sides confirmed that the electric power required for the system should be covered by the Palauan side. The facilities after the power receiving and connection to the existing monitoring system were included in the Project.

The Palauan side confirmed that PPUC should provide the electricity required within six (6) months after signing the construction contract.

7-5) Preparation of land for the proposed Malakal service tank

PPUC explained that approval of site utilization for the proposed Malakal service tank is in progress, while PPUC has all responsibility to secure the land for the proposed tank.

Both sides confirmed that the Palauan side should submit a copy of authorization for the land utilization to be issued by appropriate authority, to JICA Palau Office by 10 March 2015.

7-6) Access road to the proposed Malakal service tank

Both sides confirmed that the access road to the site for the proposed Malakal tank should be rehabilitated with gravel by the time of Pre-Qualification notice. The Palauan side confirmed that PPUC should secure necessary budget in the timely manner and execute the improvement of the access road as described in **Annex-5**.

7-7) Installation of lateral pipe

Both sides confirmed that as part of the project components, (new) distribution pipelines would be laid together with new lateral pipes to replace the existing lateral pipes provided that new ones would be laid up to private premise boundary and be closed with valves. Both sides also confirmed that rest of lateral pipes in the private premise section would be laid by PPUC and be connected to existing lateral pipes with its own fund. The PPUC understood the schedule and the cost of such works and assured to secure necessary budget according to **Annex-5**. Conceptual drawings of lateral connection are attached as **Annex-6**.

It should be noted that the existing lateral pipes should be used until commissioning of the new distribution pipelines and shifting from the old lateral pipes to the new ones would be realized by operation of valves installed on both new and old lateral pipes.

The Palauan side agreed that PPUC would assign staff to fully attend the construction works of the Japanese side to figure out the location of existing lateral pipe.

The Team emphasized the necessity of replacement for the existing lateral pipe. Since the existing lateral pipes have following characteristics which cause water leakage, the Team recommended replacing the entire lateral pipes in parallel with the replacement of distribution pipelines:

a) A lot of old lateral pipes remain.
b) Almost all the existing ones are very long so that meters are located far from roads.
c) Some facilities are constructed on lateral pipes, for example, pavement on the lateral pipes.

7-8) Technical assistance ("Soft Component" of the Project)

Considering the sustainable operation and maintenance of the provided facility, the Team explained that Soft Component for the following components was planned as the

Project scope:

a) Technical guidance for the water distribution management

b) Technical guidance for the leak detection

The Palauan side agreed that PPUC would assign ten (10) appropriate staffs in charge of the operation and maintenance to Soft Component and report the assignment plan to JICA Palau Office within 20 months after conclusion of the Exchange of Notes.

The Team also explained and the Palauan side understood that PPUC should take necessary undertakings such as over time allowance, safety measures for night-time activities.

8. Undertakings of the Palauan side

The Team explained to the Palauan side its undertakings as listed in **Annex-4**, and the Palauan side understood and agreed to execute them.

9. Necessary budget to be covered by the Palauan side

The Team explained necessary project cost to be covered by the Palauan side and necessary annual operation and maintenance cost as attached in **Annex-5**. The Palauan side agreed to secure necessary budget.

10. Environmental and social considerations

(a) Both sides confirmed that PPUC is responsible for taking any measures to complete the clearance process, in case that the relevant laws and regulations in Palau require any environmental and social considerations for implementing the Project.

(b) The environmental and social considerations process shall also follow the "JICA Guidelines for Environmental and Social Considerations"(April 2010).

(c) Both sides confirmed that PPUC conducted the Initial Environmental Examination (IEE) for the Project and submitted to the Environmental Quality Protection Board (EQPB) on October 2014 in order to examine the mitigation measures of impacts and monitoring plan during/after the project implementation.

(d) Both sides confirmed information on environmental and social considerations including major impacts and relevant mitigation measures were summarized in the Environmental Checklist attached as **Annex-7**. PPUC confirmed they would inform JICA of any major changes which might affect environmental and social considerations made for the Project by revising the Checklist in a timely manner.

(e) PPUC confirmed that the results of environmental monitoring would be provided to JICA as a part of Progress Report by filing in the monitoring results reporting form attached as **Annex-8** on a quarterly basis until the completion of the Project, provided that there was no outstanding issue regarding the environmental and social considerations during operation of the Project.

(f) In case JICA finds that there is a need for improvement in a situation with respect to environmental considerations after the agreed monitoring period, JICA may request to extend the period of monitoring and reporting until JICA confirms the issue have been properly addressed in accordance with the agreement between PPUC and JICA.

(g) PPUC confirmed it will take stipulated procedures for information disclosure in accordance with "2401-61-17, Public Review and Comment of Environmental Impact Statement Regulations". In addition, the Team requested PPUC to disclose the monitoring results to local project stakeholders, and PPUC agreed to disclose monitoring results on their website and at the PPUC offices. PPUC agreed JICA's disclosure of provided monitoring results in the monitoring form on its website.

11. Ex-Post Evaluation

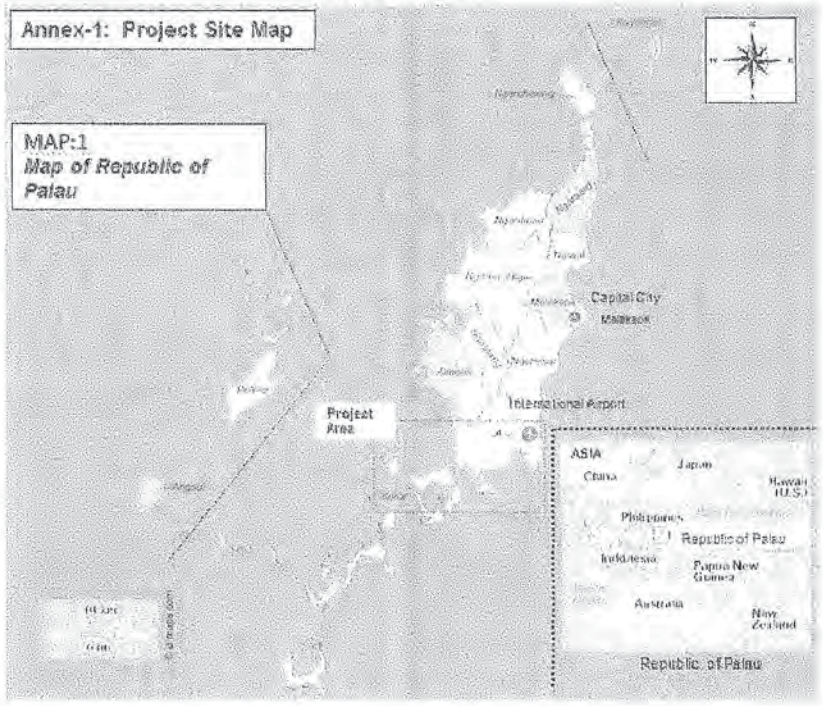
The Palauan side agreed that JICA would conduct ex-post evaluation of the Project at the time of three (3) years after the project completion with respect to five evaluation criteria (Appropriateness, Impact, Effectiveness, Efficiency, Sustainability) of the project. The Palauan side agreed to provide necessary support for the evaluation and publicize the result of evaluation.

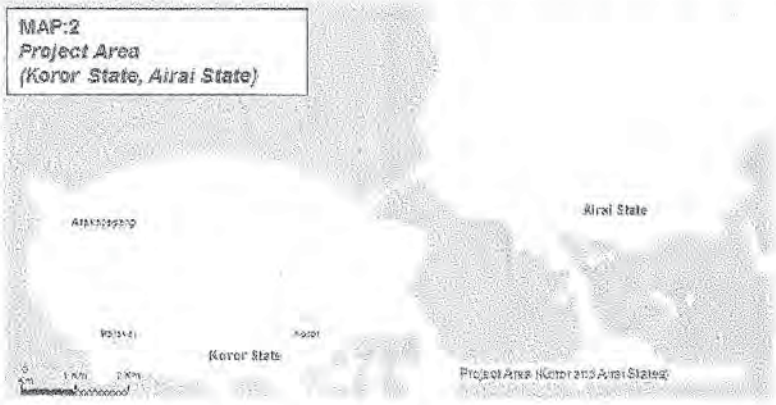
(End)

AP-4-22

Annex-1

Project Sites Map





Annex-2

Japan's Grant Aid Scheme

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

- Preparatory Survey (hereinafter referred to as "the Survey")
  - the Survey conducted by JICA
- Appraisal & Approval
  - -Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - -The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - -Agreement concluded between JICA and a recipient country
- Implementation
  - -Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex 3.

(6) Proper Use

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) Export and Re-export

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

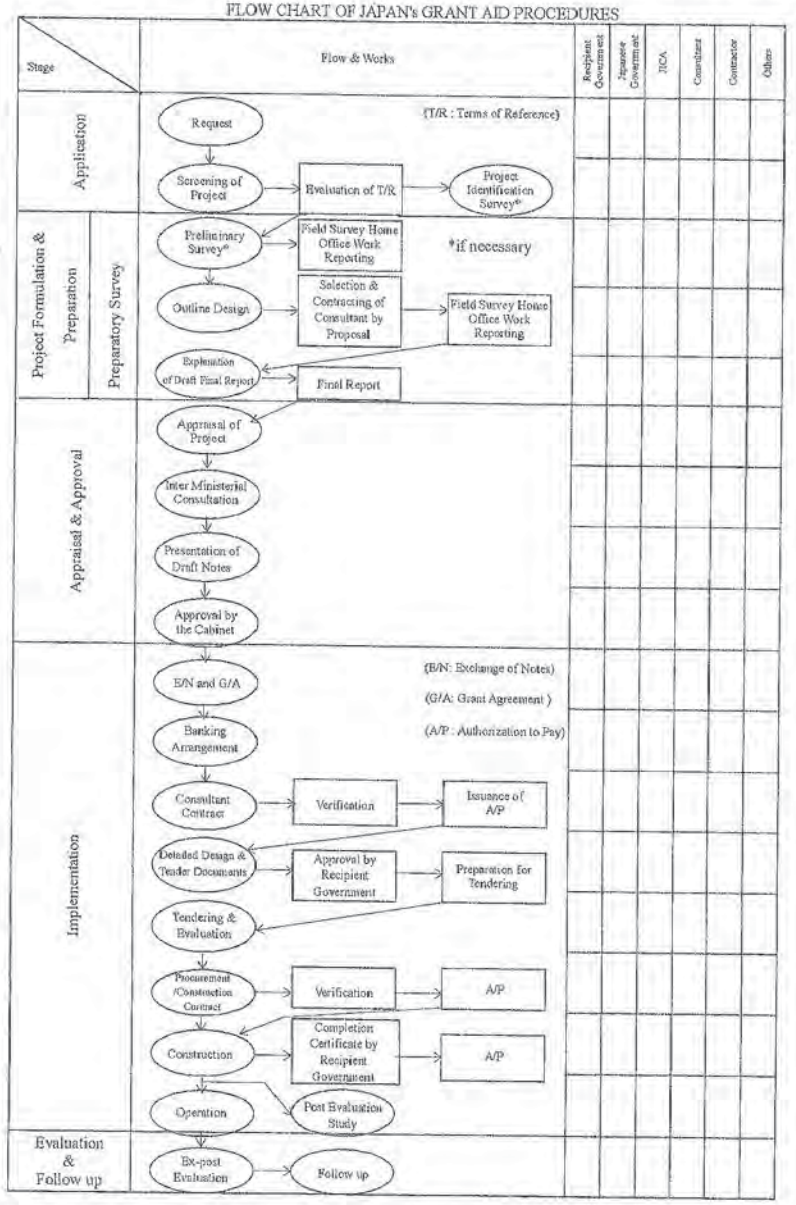
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

Attachment 1 for Annex-2

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



Attachment 2 for Annex-2

Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure [a lot] / [lots] of land necessary for the implementation of the Project and to clear the [site] / [sites].		●
2	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Internal transportation from the port of disembarkation to the project site	(●)	(●)
3	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be borne by the Authority without using the Grant		●
4	To accord Japanese physical persons and / or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
5	To ensure that the facilities and the products be maintained and used properly and effectively for the implementation of the Project		●
6	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		●
7	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
8	To give due environmental and social consideration in the implementation of the Project.		●

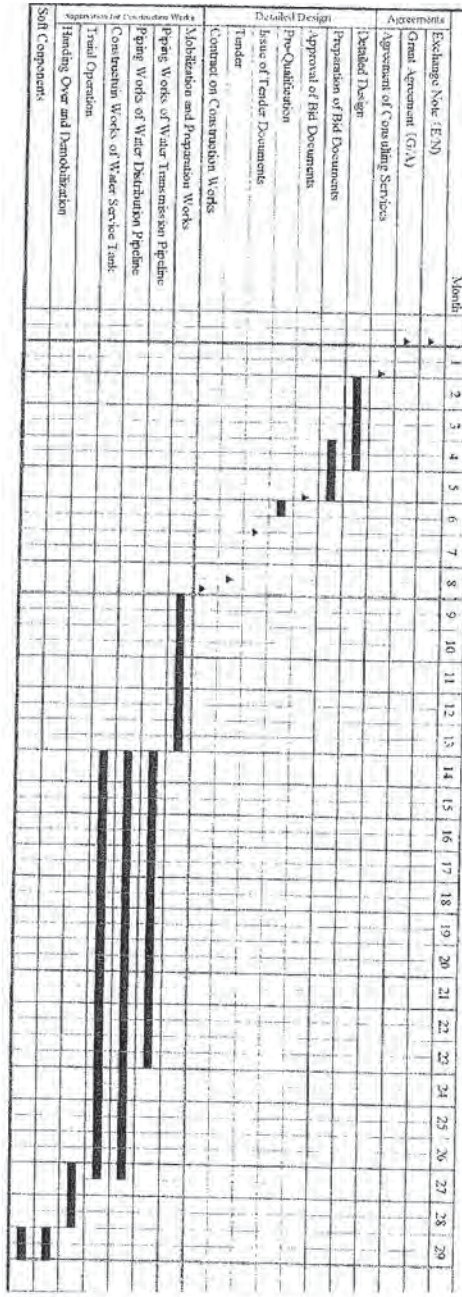
(B/A: Banking Arrangement, A/P: Authorization to pay)

AP-4-26

Annex-3

Provisional Project Implementation Schedule

THE WATER SUPPLY SYSTEM IMPROVEMENT PROJECT IN THE REPUBLIC OF PALAU



Annex-4

Undertakings of the Palauan side

No	Items	Deadlines for implementation
1	To obtain authorization for Project implementation (environment and occupation of road space). *The authorization by EQPB is attached to **Annex-4**.	Before approval of the Government of Japan
2	To explain the Project to the residents living near the construction sites and hold stakeholder meetings.	Done once. Re-organize at the starting time of construction
3	To secure the land for construction of the Project facilities through legal procedures properly.	Before approval of the Government of Japan
4	To improve the existing access roads to the construction sites for the Project.	Before PQ notice
5	To provide temporary storage and yard for construction materials.	Before PQ notice
6	To provide disposal sites for surplus soil and disinfection water.	Before PQ notice
7	To take necessary procedures for issuing A/P to the Japanese Consultant and/or Contractor(s) and to bear the following commissions to a bank in Japan for the banking services based upon the Banking Arrangement. ✓ Advising commission of A/P ✓ Payment commission	At the time of signing contract
8	To obtain construction permit from the authorities (EQPB, Koror State and Airai State) related to the Project.	Within 1 month of signing contract
9	To provide power required for Malakal service tank (The devices after the power receiving panel are the scope of the Japanese side)	Within six (6) months after signing contract with construction company
10	To ensure prompt unloading and customs clearance of the goods for the Project at the port of disembarkation in Palau	As required during construction
11	To accord Japanese nationals whose services may be required in connection with the supply of products and services under the verified contract(s), and to facilitate for their entry and stay therein for the performance of their works as may be necessary.	As required during construction
12	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Palau with respect to the supply for the products and services under the verified contract(s), and to take necessary measures for such tax exemption	As required during construction
13	To operate valves for new lateral pipes	After disinfection of pipeline
14	To assign ten (10) candidates for soft component activities and to inform JICA Palau office of them.	Intermediate during construction period
15	To install fences and gates around premise of the proposed Malakal service tank	Before handing over
16	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment	Before handing over
17	To use and maintain properly and effectively all the facilities constructed, and equipment and materials provided under the Japan's Grand Aid	After handing over

Republic Of Palau

Environmental Quality Protection Board

P.O. Box 8086
BUREAU OF PUBLIC WORKS BLDG.
KOROR, REPUBLIC OF PALAU 96940

TEL: (680) 488-1639/3600 FAX: (680) 488-2963
E-mail Address: eqpb@palaunet.com

Benjamin Adelbai Chairman | *Benjamin Yobech* Vice Chairman | *Jack Meltel* Member | *Elia Yobech* Member | *Alvina Timarong* Member | *Juliet Ngotel* Member | *Florencio Yamada* Member

February 27, 2015

Kione Isechal
CEO
Palau Public Utilities Corporation
Medalaii, Koror
Republic of Palau

EQPB Doc.#:15-622

Re: Water Supply System Improvement Project Initial Environmental Examination

Dear Mr. Isechal,

The Environmental Quality Protection Board (EQPB) has reviewed the Initial Environmental Examination (IEE) for the Water Supply System Improvement Project. The EQPB recognizes the significance of this project to the improvement of environmental quality and endorses the IEE. PPUC is subject to these following conditions:

1. PPUC must submit a Notice of Intent application for modification to a public water supply system to the EQPB.
2. Prior to commencement of construction, PPUC and its agent must submit an EQPB permit application with all applicable parts. EQPB will review the Environmental Monitoring Plan in depth upon submittal of an official EQPB permit application, which will be reviewed on a section by section basis.
3. It is recommended that earthmoving activities follow recommendations from the "Palau Erosion & Sediment Control Field Guide" (2010), available at EQPB.

The EQPB wishes to express its appreciation to the Japan International Cooperation Agency for its interest in providing support for improving the public water infrastructure of Palau.

Thank you for your kind attention to this letter. Should you have concerns or comments, please feel free to contact the EQPB Office at (680)488-1639/3600 or by email at eqpb@palaunet.com.

Sincerely,

Benjamin Adelbai
Chairman, EQPB

Attachments (0)

cc: JICA Palau Office

AP-4-28

Annex-5

Cost for Undertakings by the Palauan side, Required budget for each fiscal year and Annual Operation & Maintenance

1. Cost for Undertakings by the Palauan side

No.	Items of Obligation	Specification	Quantity	Unit price (USD)	Estimated cost (USD)
1	Improvement of access road to Malakal Service Tank (Approximately 200m)				
	Gravel	W=5m(16.5ft) t=0.3m(12in) L=200m(656.2ft)	1,000 m2	16.89	16,889.50
	Indirect cost of construction		1 Unit		6,755.80
	Sub Total				23,645.30
2	Electricity provision to Malakal Service Tank				
	Cabling Works		1 Unit		4,700.00
	Indirect cost of construction		1 Unit		1,880.00
	Sub Total				6,580.00
3	Installation of fence and gate around Malakal Service Tank				
	Installation of the fence	H=2m(6.6ft)	100 m	222.39	22,239.00
	Installation of the gate	W=4m (13.1ft), H=2m(6.6ft)	1 Unit	665.60	665.60
	Indirect cost of construction		1 Unit		9,161.84
	Sub Total				32,066.44
4	Connection of lateral pipes (308 units)				
	Connection of new lateral pipes	PVC: DM50mm(2in) 1) Straight pipe: L=2m (6.6ft) 2) Flange-Gasket: 1 piece 3) 90 degree elbow: 1 piece 4) Tee: 1 piece 5) Socket: 1 piece 6) Valve: 1 piece 7) Valve box: 1 piece	308 Units	547.17	168,528.36
	Sub Total				168,528.36
	Total				230,820.10

2. Required budget for each fiscal year

Fiscal year	Amount(USD)
2015/16	67,676.05
2016/17	163,144.05
2017/18	

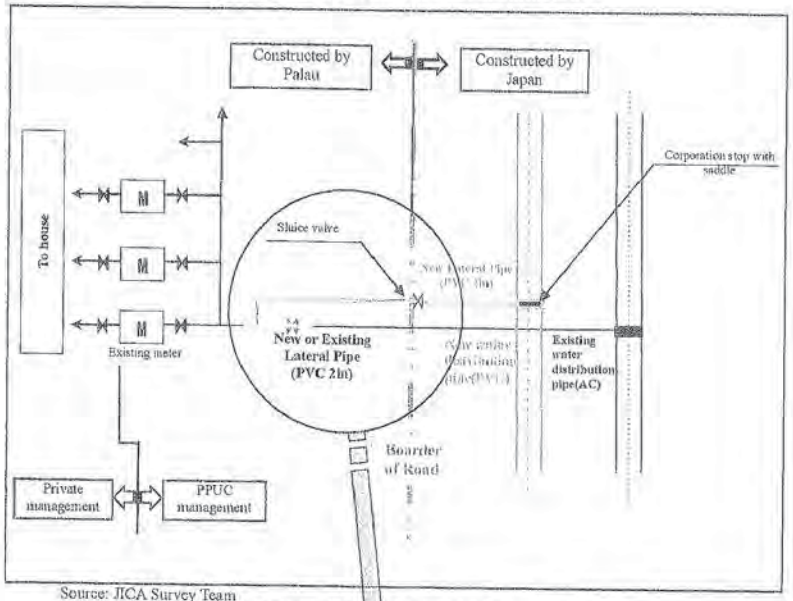
3. Annual Operation & Maintenance

Items		A	B	C	D [A×B×C]	E [D×365day/year]	F	G [E×F]
		Output (kW)	Number in Duty Unit (unit)	Operating Hour (hr/day)	Daily Power Consumption (kWh/day)	Annual Power Consumption (kWh/year)	Electricity Charge (USD/kWh)	Annual Expenses (USD)
Electricity Charge	Water Level Gauge	0.12	1	24	2.88	1,051	0.427	448.00
Items		A	B					C [A×B]
		Price of Equipment (USD)	Ratio for Spare Parts (%/year)					Annual Expenses (USD)
Spare Parts Cost	Water Level Gauge	6,400	0.03					192.00
Increment of Expenditure with the Project Implementation Total								640.00

4. Cost for Recommended Replacement of the Exiting Lateral Pipes

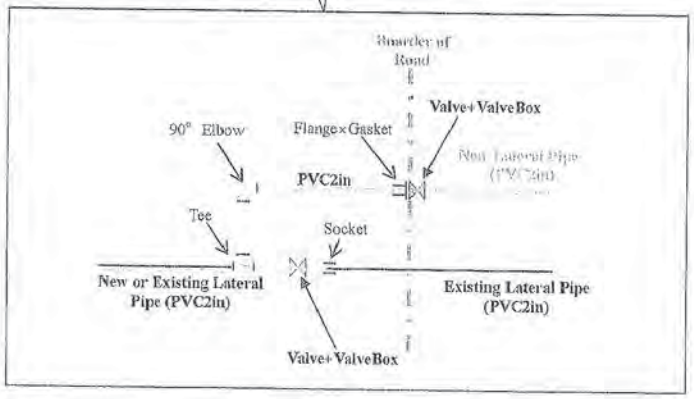
No.	Items of Obligation	Specification	Quantity	Unit price (USD)	Estimated cost (USD)
1	Replacement of the existing lateral pipes (308 units)				
	Replacement of the existing lateral pipes	PVC Pipe DN25mm(1in) L=30m (98.4ft). Including water meter, meter box	308 Units	792.72	244,157.76
	Indirect cost of construction		1 Unit		97,663.10
	Total				341,820.86

Conceptual drawings of lateral connection



Source: JICA Survey Team

Scope of Lateral Pipe and Standard Connection



Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations?	(a)Yes.	(a) No waste such as sludge is generated from the facilities to be constructed in the project. Water treatment plant generates the sludge in treatment processes. The generated sludge is properly managed and disposed. During construction stage, the Contractor transports the construction waste to M-Dock Landfill Site. The waste will be disposed properly at the landfill site.
3 Natural Environment	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a) -	(a) The project will not install any devices which generate noise, such as pump. There are no country's standards on noise, regulating water facilities such as pumping station. During construction stage, some noises and vibrations are anticipated due to construction machinery. Since no standard is available for noise / vibration, the project monitors noises and vibrations according to Noise / Vibration Regulation Laws of Japan.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a)No.	(a) There is no plan to extract the groundwater.
	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a)No.	(a) There is no possibility that the project affects the protected areas. Water service tank is planned in a far location from the protected areas. Water pipelines are planned to be installed under the existing roads. There is no construction work in conservation area for nature.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a)No. (b)No. (c)No. (d)No.	(a) Planed sites for the project facilities do not include the conserved / protected area for ecology. (b) Planed sites for the project facilities do not include the conserved / protected area for habitudes and endangered species. (c) No significant and ecological impact is anticipated. (d) The volume of in-taken water will not be increased according to the project. No adverse impact is anticipated on the surface and groundwater.
	(3) Hydrology	(a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows?	(a)No.	(a) The volume of in-taken water will not increase according to the project. No adverse impact is anticipated in hydrology of the surface and groundwater.

Annex-7

Environmental Check List

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)No. (b)No. (c)No. (d)No.	(a) IEE report has been prepared and submitted to EQPB in October 2014. The IEE report is approved by EQPB. PPUC is, however, requested by EQPB to submit the Permit Application (PA) for official approval. PA is under preparation by PPUC. According to EQPB, EIA report will not be necessary for the project. Final permit approval for construction will be based on the review of the PA and detailed design. (b), (c), and (d) As described in the above (a).
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)Yes. (b)Yes.	(a) PPUC had explanation meetings in September - December 2014 with the state Governments of Koror and Airai, Bureau of Public Works (BPW) and Capital Improvement Program (CIP) for the contents of project and mitigation measures of negative impacts such as re-pavement of road and alternative plan for Malakal service tank as well as land acquisition. (b) It was agreed that roads paved with asphalt concrete should be restored fully for the pavement surface in case for replacement of water distribution pipeline.
2 Pollution Control	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Yes.	(a) The alternative plans for pipeline routes and Malakal service tank were examined during the outline design stage.
	(1) Air Quality	(a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating measures taken? (b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	(a) - (b) -	(a) and (b) Not applicable. The project has no component related to chlorine injection and storage. No chlorine leakage is anticipated for the project during and after construction works.
	(2) Water Quality	(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	(a)No.	(a) Since the Project is not for sewage management, no effluent standard is applicable. No pollutant is generated by the facilities to be constructed. During construction stage, SS may be high in rainy days for drained rainwaters from excavated sections. No standard is available for such drained rainwater for water quality. The project, therefore, monitors SS during construction works according to Water Pollution Control Law of Japan.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?		of water pipelines such as sheet piles against landslide during excavation works. (c) Periodical meetings / trainings for construction methods and safety plans will be conducted among PPUC, the Consultant and the Contractor. (d) Since working sites will be along the existing roads, security guards will be deployed by the Contractor. For working place on asbestos pipes, Malakal service tank and stores / depots, other security guards will be deployed to prevent third parties' entry into the sites. When working on asbestos pipes, the Contractor will keep the pipes wet and enclose the site by dustproof-sheets, not to scatter the pollutants.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a)Yes. (b)Yes (c)Yes. (d)Yes.	(a) Mitigation measures such as fence around working site, utilization of low noise / vibration equipment, appropriate working hours schedule will be managed / undertaken by the Contractor. (b) (c) No adverse impact is anticipated. (d) During construction along roads, the Contractor will provide mitigation measures such as traffic guides, sign board and detours.
5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Yes. (b)Yes(c)Yes. (d)No.	(a) and (b) PPUC prepared monitoring program and forms during outline design stage. PPUC will manage data and monitor the environmental conditions during and after construction. Items and frequencies for monitoring are shown in the monitoring forms. (c) PPUC will establish a monitoring team along with the project implementation. Basically, current organization and budget for O&M of water pipelines are utilized. (d) No special requirement is given by regulatory organization for the monitoring.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked.	(a)No.	(a)Not applicable.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a)No.	(a)The project will not have adverse impacts for global issues such as trans boundary waste treatment, acid rain, destruction of the ozone layer.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, and people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a)No. (b)No. (c)No. (d)No. (e)No. (f)No. (g)No. (h)No. (i)No. (j)No.	(a),(b),(c),(d),(e),(f),(g),(h),(i),and(j) Any involuntary resettlement is not included in this project. The planned land for Malakal service tank belongs to Koror State. PPUC has discussed the approval of the land utilization with Koror State. However, there are families using the land for vegetables farms. The Koror State will undertake amicable removals of the farms.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	(a)No. (b)No.	(a) The project will contribute to improve the living conditions. No adverse impact is anticipated. (b) Surface water is utilized for the water supply. The volume of water will not be increased by the project for water supply. No adverse impact is anticipated.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)No.	(a) No heritage site is included in lands for facilities of the project.
4 Social Environment	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)No.	Main components for the project are pipelines under roads. No adverse impact on landscape is anticipated for the pipelines. Malakal service tank will be constructed at a top of hill. Since it will be small and constructed at an adjacent land of the existing tank, little adverse impact is anticipated for landscape.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a)No. (b)No.	(a)& (b) Ethnic minorities and indigenous peoples are not involved in the project site.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the	(a)No. (b)Yes (c)Yes. (d)Yes.	(a) All project activities will be implemented in accordance with laws of Palau and ordinances associated with the working conditions. (b) Sufficient protection measures are considered in the design

Annex-8

Environmental Monitoring Form

I. Institutional Requirements and Environmental Monitoring Plan

A. MONITORING FORM (Construction Phase)

-If environmental reviews indicate the need of monitoring by JICA, JICA undertakes monitoring for necessary items that are decided by environmental reviews. JICA undertakes monitoring based on regular reports including measured data submitted by the project proponent; PPUC. When necessary, PPUC should refer to the following monitoring form for submitting reports.

-When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

1. Responses/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period
Responses / Actions to Comments and Guidance from Government Authorities	

2. Mitigation Measures

- Air Quality (Emission Gas / Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Dust	-	-	-	Visual check	-	Visual check at project sites and its surrounding area, once per week.
Complaints of residents and stakeholders	-	-	-	Acceptance of complaints	-	Visual check per acceptance of complaints.

- Water Quality Effluent/Wastewater/Ambient Water Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
SS: Suspended Solid for Turbid water	mg/L	150mg/L	200mg/L	-	Mean: 150mg/L Max: 200mg/L by Water Pollution Control Law, Japan	Measurement of SS by mobile meter at excavation sites and drain channels near the sites, once per week and on rainy days.

AP-4-32

- Noise / Vibration

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise / Vibration level	db	-	85db for noise 75db for vibration	-	85db for noise by Noise Regulation Law, Japan 75db for vibration by Vibration Regulation Law, Japan	Measurement of noise / vibration by mobile meter at project sites and its surrounding area, once per week.
Complaints of residents and stakeholders	-	-	-	Acceptance of complaints	-	Visual check per acceptance of complaints

3. Social Environment

- Existing Infrastructure and Social Services

Monitoring Item	Monitoring Results during Report Period
Situation and complaints on traffic jams and temporary traffic control measures	
Duration and complaints of the residents and stakeholders for water suspension	

- Occupational Health, Safety, Labor Environment and Accident

Monitoring Item	Monitoring Results during Report Period
Arrangement of Safety Precaution	
Contents and frequency of safety meeting and training programs	

B. MONITORING FORM (Operation Phase)

-If environmental reviews indicate the need of monitoring by JICA, JICA undertakes monitoring for necessary items that are decided by environmental reviews. JICA undertakes monitoring based on regular reports including measured data submitted by the project proponent; PPUC. When necessary, PPUC should refer to the following monitoring form for submitting reports.

-When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

1. Social Environment

- Existing Infrastructure and Social Services

Monitoring Item	Monitoring Results during Report Period	Remarks (Period & Frequency)
Water pressures at residential houses: 20psi (0.14MPa) or more		Once per month

Appendix-5

Soft Component (Technical Assistance) Plan

THE PREPARATORY SURVEY

ON

WATER SUPPLY SYSTEM IMPROVEMENT PROJECT

IN THE REPUBLIC OF PALAU

SOFT COMPONENT (TECHNICAL ASSISTANCE) PLAN

Table of Contents

Soft Component (Technical Assistance) Plan

1. Background of Planning Soft Component

The Project is aiming at stable water supply to five water distribution zones in Koror and Airai States through improvement and/or rehabilitation of water supply facilities. Implementation of the Project will realize improvement of capacity of transmission main, elimination of low service pressure on water distribution pipelines, and reduction of NRW ratio. The water supply service is improved, so that, the residents are able to secure the stable drinking water.

Although NRW is a serious issue, NRW management and technology of leak detection are insufficient. It is difficult to reduce NRW ratio effectively only with facility improvement. Accordingly, the Project aims to achieve the synergy between improvement/rehabilitation of facilities and the Soft Components which is to conduct technical guidance for water distribution management and leak detection.

1) Financial Management

Although PPUC is required to be sustainable by tariff incomes, 62% of the expenditure is appropriately covered by the Governmental subsidy. The cost recovery rate is only 38%. Since the management capacity is insufficient, PPUC is supported by the ADB for sewerage improvement and program loans for water sector. Under such circumstances, PPUC commenced the tariff improvement for the water and wastewater, based on the ADB recommendations in 2009. Although the tariffs were revised in 2011 and 2012, the income has not reached a possible level for cost recovery. Currently, PPUC makes efforts to gain the community's understanding of raising the tariff through the campaigns.

Besides the tariff improvement, NRW reduction ratio (currently 48%) should be decreased in order to reduce the cost regarding water transmission and distribution.

2) Distribution / NRW Management in Water Distribution System

The Project shall commence measurement of water distribution flows at each service tank. Nevertheless, the customers and sales management zones are not in conformity with the water distribution zones. Accordingly, it is not able to compare the water flow data between distributed volume and sold volume (billed volume). It is caused by insufficient understanding on NRW and on water distribution management. Since NRW ratio is high, the management procedures should be established for water distribution and NRW, in parallel with facility improvement.

3) Leak Detection on Existing Lateral Pipe

It is difficult to detect water leakages on lateral pipes. It is because that 1) lateral pipelines are long in private plots, and 2) structures and / or pavement are constructed on the lateral pipes.

Accordingly, it is necessary for PPUC to improve their skill to detect water leakages quickly and appropriately, and to prepare proper detection programs. In addition, they need to develop their capacity for leak detection in order to maintain the effectiveness of NRW reduction in the future.

Furthermore, it will be recommended to add a function on water distribution management in the existing O&M section and to continue activities for achievement of NRW reduction target.

4) Improvement of Leak Detection Technique for Staffs and Planned Water Leakage Prevention

PPUC has one set of Leak Detector (Ground Microphone) and one set of Leak Correlator. Nevertheless the Leak Correlator has not been left unused since some of the parts were lost. The ground microphone is in good condition, and one of PPUC staff members can operate it. The leak detection is, however, sometimes difficult for PPUC staff member.

Since the skill and equipment are insufficient, it is difficult to complete the surveys for frequent water leakage. Currently scheduled detection works, which is necessary to reduce NRW, are not conducted. Accordingly, the following items are necessary to keep NRW management:

- To prepare a program for leak detection
- To prepare sufficient number of equipment
- To improve skills for leak detection

2. Targets for the Soft Component

The target for the Soft Component of the Project is to enable PPUC staffs to conduct the following works continuously after the completion of the Project:

- To manage data for water transmission and distribution in accordance with manuals, and to maximize the effectiveness of the facility utilizing the analyzed data
- To learn the leak detection skill, to make plans for leak detection survey, and to implement the leak detection

3. Output of Soft Component

The contents of the Soft Component are described as follows:

- Management of Water transmission/distribution and NRW volumes, and utilization of analyzed data for the whole water supply system
  - ✓ To record water distribution flow using a flow meter at each service tank
  - ✓ To make a customer list, including water consumption by water distribution zone
  - ✓ To grasp NRW volume using customer consumption and water distribution volume quantitatively
  - ✓ To manage NRW data
- Implementation and planning of leak detection skill and the prevention plan.
  - ✓ To identify water leakages properly
  - ✓ To learn leak detection skill as well as utilization of equipment in accordance with the manual
  - ✓ To make a scheduled work program for leak detection
  - ✓ To feedback water leakage information to management plan of water transmission main /distribution pipeline

4. Methods for Confirming Achievement of Outputs

The achievement level for outputs from the Soft Component will be confirmed with the acquirement level on knowledge and improvement level of daily routine works.

- Acquirement level on knowledge: small tests at the end of training
- Daily work improvement using acquired knowledge: monitoring of work

Table-1 shows the check items for output achievement level of the Soft Component.

Table-1 Method of Evaluation of Achievement

Category	Output	Evaluation Items
Management of water transmission/distribution and NRW volumes, Utilization of analyzed data for the whole water supply system.	To record water distribution flow using flow meter at each service tank.	✓ To record water distribution flow, and sort out accurately by graphs.
	To make customer list, including water consumption by water distribution zone.	✓ To coordinate the billed water data (consumption data) with each water distribution zone using the customer list.
	To grasp NRW volume using customer consumption and water distribution volume quantitatively.	✓ To calculate NRW volume on distribution / lateral pipes, using water distribution flow data and customer consumption data. ✓ To calculate NRW volume on transmission main, using water level data of every distribution service tank and water flow data of outlet flow meter at KAWTP.
	To manage NRW data.	✓ To prioritize water distribution zones, using data of NRW ratio and the customer list.
Implementation and planning of leak detection technology and the prevention plan.	To identify water leakages properly. To learn leak detection skill as well as utilization of equipment in accordance with the manual.	✓ To understand principles and characteristics of the leak detection equipment. ✓ To use equipment in accordance with the manual. ✓ To identify water leakages properly.
	To make a scheduled work program for leak detection. To feedback water leakage information to management plan of water transmission main /distribution pipeline.	✓ To make and implement leak detection schedule with NRW reduction plan. ✓ To make a report of water leakage location record. ✓ To feedback the cause of water leakages to improvement of water transmission main /distribution pipelines maintenance plan after leak detection.

Source: JICA Survey Team

5. Soft Component Activities (Input Plan)

1) Contents of the Soft Component

The activity contents of the Soft Component are as follows. The work schedule is shown in Table-2.

- Preparation of training schedule
- Preparation of training text (manuals)
- Preparation of templates of water distribution flow, customer consumption and NRW (MS-Excel)

- Practical training of screening survey and ground microphone survey for leak detection
- Implementation of lectures / practices
- Preparation of report of water leakage repair
- Preparation of the water leakage prevention plan / NRW reduction plan
- Evaluation of the achievement (outputted as a report)

In addition, 2 sets of Leak Detector (Ground microphone and electric/non-electric Listening Stick) are procured for leak detection training. This equipment is able to detect water leakage for both water distribution pipelines and lateral pipes. Furthermore, this equipment is easy to handle even for new staff members.

Table-2 Implementation Schedule (Proposed)

Category	Training	Days																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Water Distribution Analysis	NRW management																														
	Distribution Zones Investigation																														
Leakage Detection Technique	Leakage Detection Plan / Analisis of Water Distribution Flow																														
	Lateral connection / Ground Surface Survey																														
	Confirmation																														

Source: JICA Survey Team

2) Trainer for the Soft Component

Two (2) Japanese consultants are deployed as trainers of the Soft Component. One (1) expert is for water distribution analysis and another expert is for water leak detection.

3) Candidate Trainees

The candidate trainees are ten (10) personnel from WWO and Administration in PPUC. In addition, these candidate participants should be informed to JICA Palau Office from PPUC until the intermediate time of the construction period.

- The candidate trainees are mainly the person(s) in charge of O&M for facilities, which is constructed by the Project.
- Although the trainees are divided into two (2) teams for water distribution analysis and for leak detection, all ten (10) personnel are able to learn and understand the training contents of the both parts.

6. Procurement of Trainer Resources of the Soft Components

The Soft Component is to support overall management for Koror - Airai water supply system and to support utilization of the leak detection skill.

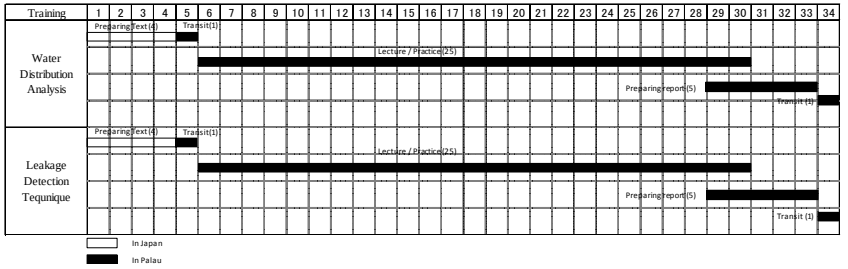
Accordingly, the trainer in charge of the overall management is required to be familiar with this water distribution system and involved in the design of facilities. On the other hand, the trainer

in charge of leak detection is required to be familiar with leak detection equipment. These are reasons that a direct support program by the Japanese Consultant is appropriate.

7. Implementation Schedule for the Soft Component

The Soft Component will be conducted at around completing time of facilities' construction and / or trial operation period since the activity of the Soft Component is necessary to operate the facilities to be constructed. Table-3 shows the proposed implementation schedule of the Soft Component for the Project. Activity schedule shall be set in the most rational way taking into account minimizing the input of the Japanese Consultant.

Table-3 Proposed Implementation Schedule for the Soft Component



Source: JICA Survey Team

8. Deliverables in the Soft Component

Deliverables to be prepared in the Soft Component are listed in Table-4

Table-4 Documents to be Prepared in the Soft Component

Items	Remarks
Data management manual of NRW	Record sheet of water distribution flow and customer consumption Record of calculated NRW
Leak detection manual and the survey program plan	Proposed leak detection program plan Screening survey manual (individual houses, ground surface survey)
Evaluation report on achievement of trainees	Evaluations and results of small test and Q&A sheet for trainees
Final report for the Soft Component (English)	Conforming to the 3rd edition (October in 2010) of the Soft Component guideline of JICA
Final report for the Soft Component (Japanese)	Same as the above

Source: JICA Survey Team

9. Responsibilities of the Implementation Agency

1) Viability for Implementation

The objectives and contents of the Soft Component in the Project are desirous ones for PPUC to improve cost effectiveness of water supply. Accordingly, the viability of the Soft Component is very high.

In order to achieve the objectives of the Soft Component, institutional and financial conditions of PPUC should be guaranteed.

Currently, PPUC has thirty five (35) staff members in total related to the O&M for water supply facilities. It is considered that O&M for the facilities to be constructed in the Project can be conducted by the exiting staffs or reallocation/rotation of the current staff members.

In addition, for the financial conditions, PPUC's expenditure for activities in the Soft Component is estimated as little. It is, therefore, considered that PPUC is capable of bearing necessary undertakings for the Soft Component.

2) Impeding Factor and Required Action by PPUC

No impeding factors in training items are expected. The trainees, however, may have business trips sometimes for emergency accidents in outlaying states. To prepare for such situation, average training hours per day should be planned for 3 to 4 hours.

PPUC and the trainees for the Soft Component should satisfy the following requirements. In order to meet these requirements, PPUC is required to make the candidate trainees learn the necessary skills before the training. Also, key personnel for O&M should be trained for all the items of the Soft Component.

- To learn a basic skill to use a computer system (MS-Excel and MS-Word).
- To secure enough time necessary for class-room training and practical training (3 to 4 hours a day).
- To secure training room: one (1) room having enough space for 10 to 15 trainees in PPUC office.

For [the data management of water distribution flow and NRW volume], PPUC should arrange hardware such as computers before the training. For the hardware of the training, JICA Survey Team had already confirmed at the time of outline design stage that PPUC had all necessary equipment including computers and they were able to utilize their hardware for the training.

In the activity for [Leak detection technology and prevention planning], the survey includes "nighttime activity". PPUC should prepare safety arrangement for prevention of traffic accidents before the activity. The nighttime overwork payment is also required for trainees.