REPUBLIC OF THE MARSHALL ISLANDS
MAJURO WATER AND SEWER COMPANY (MWSC)

THE PREPARATORY SURVEY OF THE PROJECT FOR THE IMPROVEMENT OF WATER RESERVOIR AT MAJURO ATOLL IN REPUBLIC OF THE MARSHALL ISLANDS

FINAL REPORT

JULY 2020

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.
JAPAN TECHNO CO., LTD.

GE
CR(1)
20 - 039

REPUBLIC OF THE MARSHALL ISLANDS
MAJURO WATER AND SEWER COMPANY (MWSC)

THE PREPARATORY SURVEY OF THE PROJECT FOR THE IMPROVEMENT OF WATER RESERVOIR AT MAJURO ATOLL IN REPUBLIC OF THE MARSHALL ISLANDS

FINAL REPORT

JULY 2020

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.
JAPAN TECHNO CO., LTD.

PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to the consortium consisting of Yachiyo Engineering Co., Ltd. and Japan Techno Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Government of the Republic of Marshall Islands, and conducted a field investigations. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Republic of the Marshall Islands for their close cooperation extended to the survey team.

July, 2020

Eiji Iwasaki
Director General
Global Environment Department
Japan International Cooperation Agency

SUMMARY

1. Outline of Republic of the Marshall Islands (RMI)

Republic of the Marshall Islands (hereinafter referred to as "RMI") is made up of five independent islands and 29 atolls totalling about 1,225 coral islands covering a land area of approximately 180 km^2.

It has an oceanic tropical climate with strong sunlight during the day, but trade winds from the sea make life relatively more comfortable in the morning and evening. The average annual temperature is around 81 °F (27 ° C). The dry season is from January to March, the rainy season is from October to November, and the annual precipitation is about 126 in. (3,200 mm).

The population of RMI has reached around 58,000 persons (World Bank Population Survey, 2017), and about 29,000 of them (assumed as of 2019) live in Majuro.

According the World Bank statistics, Gross National Income (GNI) in 2018 was about USD 280 million, which interprets to about USD 4,860 per capita.

2. Background of the Project and Basic Concepts

In atoll countries like RMI without surface water body such as river and lake, it is difficult to secure water, which results in that people much rely on rainwater fluctuating. As a feature of water supply in Majuro, most of the households have individual rainwater tanks to use rainwater for domestic purposes preferentially, and they use not only the individual rainwater tanks but also the public water supply system. Especially, public water supply system serves very essential function in case of rainwater shortage at the individual rainwater tanks during drought.

Currently, ensuring stable water supply is urgently required, because RMI is facing an increase in water demand, rainwater reservoir leakage and extreme change in rainfall intensity. Under environment that atoll countries face drought due to climate change, public water supply service is very important for water security to supply water for domestic use. Therefore, extension of rainwater reservoir is a very necessary and urgent project in RMI.

RMI prepared "Agenda 2020 of RMI", an overall plan focusing on "Water, Energy and Food Security". According to the plan, RMI suggested the "Extension of Rainwater Reservoir in Majuro" as an action plan until the year of 2020. MWSC formulated the "20-year Water and Sanitation Strategic Plan (2017)", which is a strategic development plan focusing on improvement in water and hygiene service in Majuro in the next 20 years.

In the "20-year Water and Sanitation Strategic Plan (2017)", development of the rainwater reservoirs with a total capacity of 46 MG (174,129 m^3) were planned. The plan includes 16 MG (60,567 m^3) and 30 MG (113,562 m^3) capacity reservoirs in the areas beside the airport and the Peace Park, respectively. RMI requested the Japanese Government to develop the rainwater reservoir with a capacity of 16 MG (60,567 m^3) as a grant aid project (hereinafter referred to as "the Project") (see Table 1).

Table 1 Outline of the Request by RMI

Items		Original Request
Facility	Construction of a rainwater reservoir for Treatment Plant C	Construction of rainwater reservoir with storage capacity of about 16 MG (60,567 m^3) and revetment to prevent erosion and adverse effects of salinity on the rainwater reservoir
	Rehabilitation of the existing rainwater reservoirs	Rehabilitation of the existing six rainwater reservoirs
Equipment	Development of water supply system	Installation of a rainwater transmission pump between the rainwater collection facilities and the proposed rainwater reservoir
	Installation of a solar power generation system	Installation of a solar power generation system on the proposed rainwater reservoir
	Operation and maintenance	Procurement of a conductivity detector for alarming intrusion of sea water, and a high pressure cleaner for flushing out sludge/ sand in the rain catchment basin and conduit

Source: MWSC

3. Result of the Survey and Contents of the Project

Japan International Cooperation Agency (hereinafter referred to as "JICA") headquarters sent JICA Survey Team to RMI from May 18 to June 30, 2019. JICA headquarters had a plan to send the draft final report mission to RMI around March 2020, but canceled it because of the world corona-virus pandemic. Instead of the draft final mission, JICA headquarters organized a TV conference on March 27 and May 15, 2020 in order to confirm the progress of land lease negotiation between RMI Government and landowners, and explain the draft outline design to the implementing organizations such as MWSC and MWIU.

Overall goal of the Project is that "To ensure potable and domestic water at Majuro Atoll in the future under all conditions, even during drought".

In order to achieve the above overall goal and project purpose, a rainwater reservoir and rainwater transmission pipelines will be developed, and revetment will be constructed to prevent erosion and adverse effects of salinity on the rainwater reservoir.

The development of the additional rainwater reservoir is expected to increase the raw water storage capacity.

This primary aim of the Project is to augment the water storage capacity to improve the water supply during drought. Therefore, the Project will construct a new rainwater reservoir in order to achieve as many water supply days as possible. The storage capacity increase will be set considering the optimum use of the site required for the proposed rainwater reservoir.

3.1 Revetment

The design crest level of the revetment will be set considering extra height to be added to the design wave height, to ensure that the seawater pushed by wind waves does not affect the water stored in the proposed rainwater reservoir. The quarry site for rock required for revetment construction should be selected from in inland areas, because there are corals at reef edges and/or in more offshore areas. When digging for rocks at the quarry site, corals must be protected by using a silt fence, etc.

The necessary input data such as the design wave, the design tidal level, and sea level rise for the basic design of the revetment was discussed, and the stability of the revetment against waves was examined.

3.2 Rainwater Reservoir

The surface area of the proposed rainwater reservoir is around 5.7 ac (2.3 ha), and it is surrounded by the existing rainwater reservoir No. 6, Iakwe Katoj Park, the eastern boundary fence of Majuro International Airport and reef edge. This area is limited by the above land condition. The capacity of the proposed rainwater reservoir was designed based on the proposed layout of revetment along reef edge. The clearance between the eastern boundary fence of Majuro International Airport and the proposed facility perimeter is 11 ft (3.35 m) in accordance with the agreement with the Civil Aviation, RMI Port Authority (RMIPA).

3.3 Transmission Facilities

Transmission facilities are composed of 1) Inlet/Outlet Pipelines, 2) Sub-drain Pipeline and Drainage Pipeline, 3) Air Ventilation Pipeline and 4) Overflow Pipelines.

To transfer the rainwater to the proposed rainwater reservoir, a branch with the same diameter as the existing pipe (14 in. or 356 mm) will be installed in the existing transmission pipeline between the existing pump station No. 4 and the rainwater reservoir No. 6, and the branch and the proposed rainwater reservoir will be connected by a new inlet/outlet pipeline.

Under the lining sheet of the existing rainwater reservoir, sub-drain pipelines will be installed to drain the water leaked through the lining sheet. In addition, Air ventilation pipelines will be installed in the embankment of the existing rainwater reservoir to eliminate uplift pressure at high tide and during sea level rise. Furthermore, an overflow pipe will be installed in case excessive water is pumped from the pump station No.4 and/or rain falls, when the rainwater reservoir is full.

3.4 Summary of the Project Components

Table 2 shows the Project Components.

Table 2 Summary of the Project Components

Component	Outlines
Revetment	● Length: 335 m ● Structures：Sloping rubble mound-type
Rainwater reservoir	● Storage capacity: 15 MG (56,900 m^3)
Transmission pipelines	● Composition: 1) Inlet & outlet pipelines (14 in. (356 mm)), 2) Sub-drain Pipeline and Drainage Pipelines, 3) Air Ventilation Pipelines, 4) Overflow Pipelines

Source: JICA Study Team

4. Implementation Schedule of the Project and Project Cost Estimate

The expected Project completion period is about 33 months which are composed of detailed design: about seven months, tendering including pre-approval of the Project by the Japanese Government: about four months and implementation including conditioning & inspection: about 22 months.

Information on total project cost is closed due to the confidentiality until final certification of the contract of the contractor. The cost of implementing the Project to be borne by RMI is estimated at JPY7.0 million (under exchange rate of USD1.00=JPY111.95).

5. Project Evaluation

5.1 Relevance

Relevance of the Project is summarized as below.

(1) RMI's Policy

The policy includes strengthening the measures against climate change, and preparation for disasters caused by the climate change. National actions are required for ensuring potable water in drought period. The proposed rainwater reservoir is highly prioritized in the national policy as a measure against climate change.

(2) Japanese Government Policies

The Project is related to environment and climate changes, key sectors of the bilateral cooperation. In addition, the Japanese Government focuses on measures against water scarcity in drought period, and measures against high waves at high tide.

Moreover, Japanese Government focuses on strengthening the foundation for sustainable development in conformity with the declaration of the leaders at the Eighth Pacific Islands Leaders Meeting (PALM8) in May 2018, which adopted the cooperation on disaster prevention and climate change as one of its pillars.

(3) Relevance of the Project

The Project is to strengthen measures against and the preparation for climate change and related disasters in RMI by improving water security in drought period. The improvement of the water supply and measures against climate change are in line with the bilateral cooperation policy, and the Project can contribute to Goal 6 (Water Security) and Goal 13 (Climate Change) of Sustainable Development Goals (SDGs). Accordingly, the Project is very important.

5.2 Effectiveness

The effectiveness of the Project is summarized below.

(1) Quantitative Effects

Table 3 shows the baseline condition and the Project effect, quantitatively.

Table 3 Quantitative Effect of the Project

Indicator	Baseline （Assumed baseline year: 2019）	Goal (Three year after the Project is completed: 2026)
Total number days that water can be supplied to the WTP-C continuously in drought period	55 days	74 days

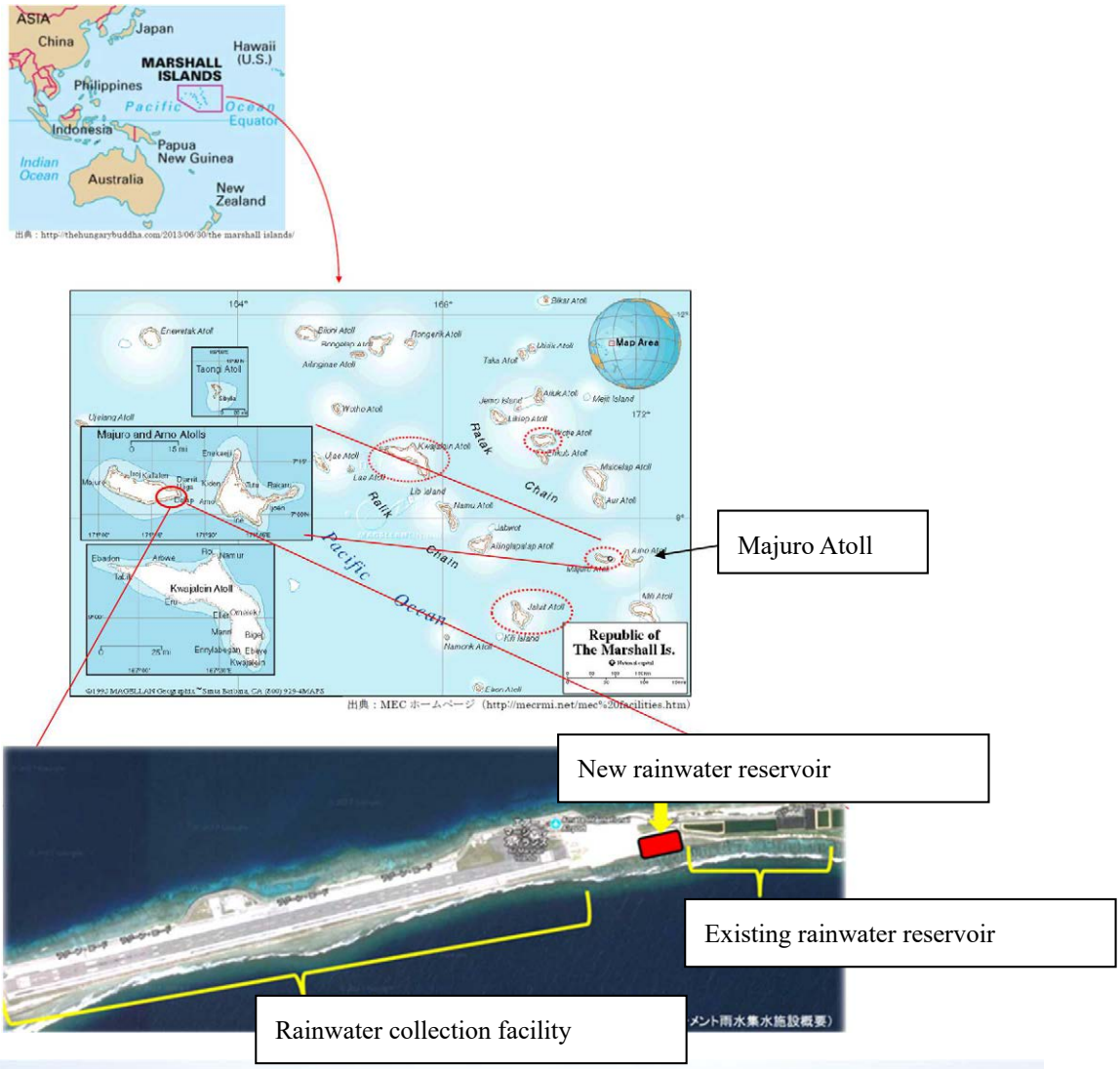
Source: JICA Survey Team

Moreover, after completion of the Project, unless new rainwater reservoirs are developed, total number of days that water can be supplied to the WTP- C continuously in drought period will be shortened from 74 days as of 2026 to 63 days as of 2050.

(2) Qualitative Effects

- Improvement in quality of life and public hygiene through the improvement of water supply service, such as reduction of water rationing.
- Making sound water circulation by reduction of intake from fresh lens layer during drought period.

CONTENTS



LOCATION MAP (CONSTRUCTION SITE FOR THE PROJECT)

PERSPECTIVE

LIST OF FIGURES AND TABLES

CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

CHAPTER 3 PROJECT EVALUATION

ABBREVIATIONS

[Organization]	
ADB	Asian Development Bank
ADFD	Abu Dhabi Fund for Development
AG	Attorney General
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CIA	Central Intelligence Agency
CIRIA	Construction Industry Research & Information Association
DFR	Draft Final Report
DIDA	Division of International Development Assistance, Ministry of Finance
EPD	Energy Planning Division
EPPSO	Economic Policy, Planning and Statistics Office
FAA	Federal Aviation Administration
GCF	Green Climate Fund
HPO	Historic Preservation Office
ICDF	**International Cooperation and Development Fund**
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
KAJUR	Kwajalein Atoll Joint Utilities Resources Inc.
KALGov	Kwajalein Atoll Local Government
MCIA	Ministry of Culture and Internal Affairs
MEC	Marshalls Energy Company
MFPS	Ministry of Finance and Postal Service
MIMRA	Marshall Islands Marine Resources Authority
MJIL	Ministry of Justice, Immigration and Labor
MOF	Ministry of Finance
MoTC	Ministry of Transport and Communications
MWSC	Majuro Water & Sewer Company
NTA	National Telecommunication Authority
MWIU	Ministry of Works, Infrastructure, and Utilities
NEO	National Energy Office
NOAA	National Oceanic and Atmospheric Administration
OEPPC	Office of Environmental Policy, Planning and Coordination
OSAC	Overseas Security Advisory Council
PPA	Pacific Power Association
PSS	Public School System
RMI	Republic of the Marshall Islands
RMIEPA	Republic of the Marshall Islands Environmental Protection Authority
RMIPA	Republic of the Marshall Islands Ports Authorities
SPREP	The Secretariat of the Pacific Regional Environment Programme
USOSHA	United States Occupational Safety and health Administration
WACOP	Changing Waves and Coasts in the Pacific
[General]	
A/P	Authorization to Pay
B/L	Bill of Lading
CBR	California Bearing Ratio
COMPACT	Compact of Free Association with the United States

EEZ	Exclusive Economic Zone
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Regulations
EL	Elevation
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
EPA	Earthmoving Permit Application
GIS	Geographic Information System
GNI	Gross National Income
HWL	High Water Level
JIS	Japanese Industrial Standards
JNAP	Joint National Action Plan for Climate Change Adaptation and Disaster Risk Management
LWL	Low Water Level
M/D	Minutes of Discussion
ODA	Official Development Assistance
OJT	On-the-Job Training
O&M	Operation and Maintenance
PAPs	Project Affected Persons
PDM	Project Design Matrix
PEA	Preliminary Environmental Assessment
RC	Reinforcement Concrete
SDGs	Sustainable Development Goals
SEAFRAME	Sea Level Fine Resolution Acoustic Measuring Equipment
SPT	Standard Penetration Test
TCF	Technical Cooperation Facility
TOR	Terms of Reference
UFC	The United Facility Criteria
VAT	Value Added Tax

[Unit]

%	percentage
°C	degrees Celsius
ac	acre
cm	centimeter
G, gal	gallon
GPD	gallon per day
ha	hectare
in.	inch
ft	feet (foot)
ft^2	square feet
ft^3	cubic feet
kg	kilogram
km	kilometer
km^2	square kilometer
kW	kilowatt
L	litter
LCD	litter per capita per day
lb	pound
m	meter
m^2	square meter

m^3	cubic meter
MG	mega gallon (million gallon)
MGD	mega gallon (million gallon) per day
mi	mile
mi^2	square mile
min	minute
mm	millimeter
MPa	mega- Pascal
MW	megawatt (million watt)
N	newton
psi	pound per square inch
USD	United States Dollar

[Unit Conversion]

1. Length: 1 m = 3.281 ft = 39.370 in., 1ft = 12 in., 1 km = 0.621 mi
2. Area: 10,000 m^2 = 1 ha =2.471 ac = 107,639 ft^2 = 0.00386 mi^2
3. Volume: 1 m^3 = 1,000 L = 35.315 ft^3 = 264.172 gal (US Unit)
4. Weight: 1 kg = 2.205 lb
5. Pressure and Strength: 1 MPa = 1 N/mm^2 = 145.038 psi = 0.145038 ksi

CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 Background of the Project

Approximately 29,000 people live in Majuro, the capital of Republic of the Marshall Islands (hereinafter referred to as "RMI"). In atoll countries like RMI without surface water body such as river and lake, it is difficult to secure water, which result in that people much rely on rainwater fluctuating. As a feature of water supply in Majuro, most of the households have individual rainwater tanks to use rainwater for domestic purposes preferentially, and they use not only the individual rainwater tanks but also the public water supply system. Especially, public water supply system serves very essential function in case of rainwater shortage at the individual rainwater tanks during drought. Ensuring stable water supply is urgently required, because RMI is facing an increase in water demand, rainwater reservoir leakage and extreme change in rainfall intensity.

Majuro Water and Sewer Company (hereinafter referred to as "MWSC") is responsible for the public water supply service in Majuro to supply treated water to the dwellers. MWSC has focused on improvement (increase in connections and quantity of water) in water supply service for the next 20-year. Therefore, MWSC formulated "20-year Water and Sanitation Strategic Plan (2017)", which is a strategic development plan focusing on improvement in water and hygiene service in Majuro. The Strategic Plan was based on RMI's "Agenda 2020 of RMI", an overall plan focusing on "Water, Energy and Food Security", which suggested the "Extension of Rainwater Reservoir in Majuro" as an action plan until the year of 2020.

Under environment, that atoll countries face drought due to climate change, as mentioned above, public water supply service is very important for water security to supply water for domestic use. Therefore, extension of rainwater reservoir is a very necessary and urgent project in RMI.

In the "20-year Water and Sanitation Strategic Plan (2017)", development of rainwater reservoirs with a total capacity of 46 MG (174,129 m^3) were planned. The plan includes 16 MG (60,567 m^3) and 30 MG (113,562 m^3) capacity reservoirs in the areas beside Majuro International Airport and the Peace Park, respectively. RMI requested the Japanese Government to develop the rainwater reservoir with a capacity of 16 MG (60,567 m^3) as a grant aid project.

The JICA Survey Team (hereinafter referred to as "the Team") summarized the overall goal and specific purpose of the Project for Improvement of Water Reservoir at Majuro Atoll in the Republic of the Marshall Islands (hereinafter referred to as "the Project") as follows:

(1) Overall Goal

To ensure potable and domestic water at Majuro Atoll in the future under all conditions, even during drought

(2) Project Purpose

To increase storage capacity required for the WTP-C through the construction of a rainwater reservoir

1-2 Natural Condition

(1) Location of the Proposed Project Site

The proposed Project site, which has an area of about 5.7 ac (2.3 ha), is located on the east side of Majuro International Airport in Majuro city, Majuro Atoll. There are two clean water reservoirs and five rainwater reservoirs around the Project site. In addition to the five rainwater reservoirs, there is the rainwater reservoir No.6, which is located on the lagoon side. The proposed Project site is regulated in terms of height of structure and construction machineries. Iakwe Katoj Park, which was developed by the funds of embassies, international donors, private companies, and others is found on the north side of the proposed Project site. Therefore, the Ministry of Works Infrastructure Utilities (hereinafter referred to as "MWIU") expects the construction of the Project to proceed as much as possible without affecting the park.

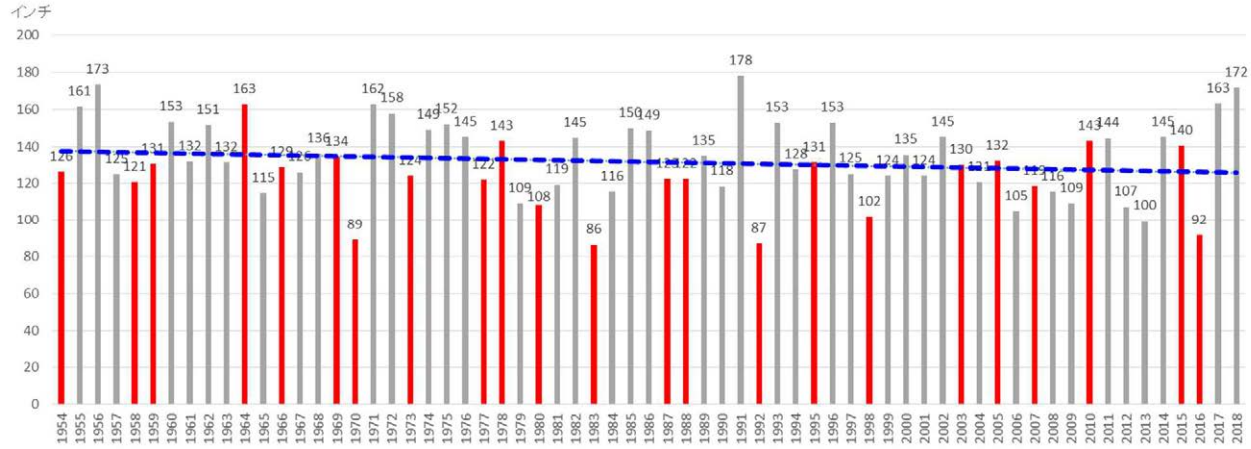
(2) Weather Condition

The climate of RMI is marine tropical with strong sunlight. However, trade wind from the sea makes life relatively more comfortable in the morning and evening. The average annual temperature is around 81°F (27°C). The dry season is from January to March, the rainy season is from October to November, and the annual precipitation is about 130 in. (3,300 mm).

1) Changes in Annual Precipitation

Figure 1.2-1 shows the changes in annual precipitation in Majuro from May 1954 to December 2018. The years marked in red indicate the ones in which El Nino events were recorded.

Looking at the annual rainfall trend over the past 65 years, the annual rainfall was about 140 in. (3,556 mm) in the 1950s, but has recently fallen to the lower half of 130 in. (3,302 mm).



Source: JICA Survey Team

Figure 1.2-1 Changes in Annual Precipitation

Table 1.2-1 shows the years in which the annual precipitation has fallen below 109 in. (2,769 mm). In addition, the table confirms that the intervals between the above low precipitations years have been decreasing recently.

Table 1.2-1 Annual Precipitation of the Years with Precipitation below 109 in. (2,769 mm)

	1970	1979	1980	1983	1992	1998	2006	2009	2012	2013	2016
Rainfall (in.)	89	109	108	86	87	102	105	109	107	100	92
Intervals between the years with precipitations below 109 in.	-	9 years	1 year	3 years	9 years	6 years	8 years	3 years	3 years	1 year	3 year

Source: JICA Survey Team

2) Past Drought

Table 1.2-2 summarizes the droughts that have occurred in RMI since 1991.

Table 1.2-2 Drought since 1991

Year	Month	Areas affected by drought	Description
1992	N.A.	The whole of RMI	Long dry season with insufficient rainfall
1998	N.A.	The whole of RMI	Decrease in rainfall due to El Nino event
2006	N.A.	The whole of RMI	Long dry season with insufficient rainfall
2009	N.A.	The whole of RMI	Ditto
2013	N.A.	Aliluk, Kwajalein, Likiep, Mejit, Utrok, Enewetak, Wotho, Wotje, Aur, Lae, Lib, Maloelap, Ujae	Ditto
2015 to	Nov. 2015 to	The whole of RMI	Decrease in rainfall due to El Nino

Year	Month	Areas affected by drought	Description
2016	Aug. 2016		event
2017	Nov. 2016 to Jun. 2017	Aliluk, Kwajalein, Likiep, Mejit, Utrok, Enewetak, Wotho, Wotje, Aur, Lae, Lib, Maloelap, Ujae	Long dry season with insufficient rainfall

Source: Revised based on Statistical Year Book 2017

3) 2015-2016 Drought

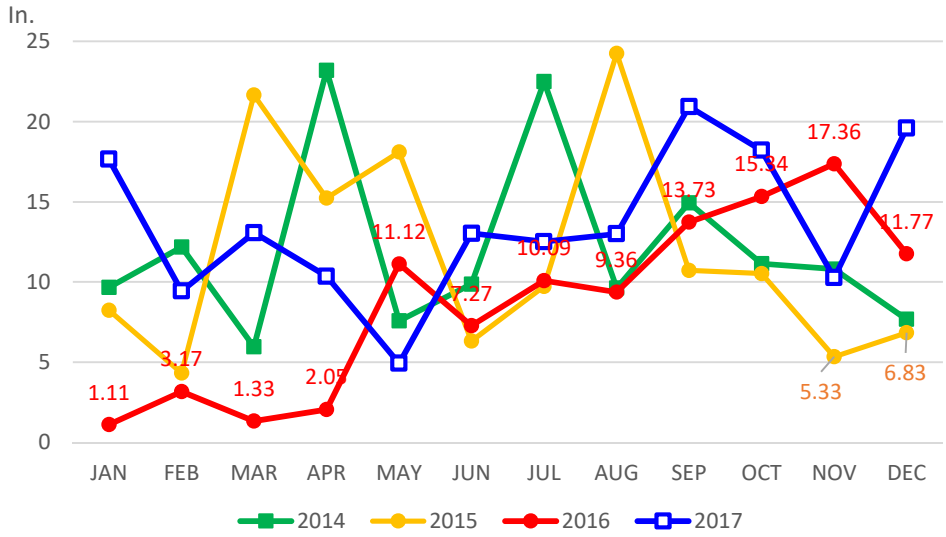
Damage caused by the 2015-2016 drought is summarized in Table 1.2-3.

Table 1.2-3 Overview of Drought from the year 2015-2016

Items	Contents
Causes	El Nino event
Drought victims (assumed)	53,158 persons
Economical loss (assumed)	4.9 million USD
Declaration of a state of emergency	3 Feb. 2016: State of Drought Emergency 4 Mar. 2016: State of Disaster (afterward, extended twice) 27 Apr. 2016: Declaration of Drought of Disaster by US president

Source: JICA Survey Team based on "Post Disaster Needs Assessment of the 2015-2016 Drought"

Figure 1.2-2 shows monthly precipitation between the 2014 and 2017. It clearly shows that rainfall from November 2015 to April 2016 was remarkably low.



Source: JICA Survey Team

Figure 1.2-2 Monthly Precipitation between the year 2014 and 2017

The rainfall in the period between November and April of the 2015-2016 drought year is compared with that in the same period of a normal year as shown in Table 1.2-4. The result shows that the rainfall in the normal year is three times higher than that in the drought year.

Table 1.2-4 Rainfall between November and April from 2013 to 2017

Items	Nov. 2013 to Apr. 2014	Nov. 2014 to Apr. 2015	Nov. 2015 to Apr. 2016	Nov 2016 to Apr. 2017
Rainfall (in.)	72.86	71.38	23.51	83.21
Rainfall in normal year/ in drought year	310%	304%	100%	354%

Source: JICA Survey Team

According to Post Disaster Needs Assessment of the 2015-2016 Drought, in Majuro, 77 % of the population use rainwater as their primary water source. Of those, only 19 % of households have secondary piped water from MWSC. There was a 5 % increase in household connection to MWSC during the drought, and those not connected to MWSC, increased bottled water consumption and free temporary water collection points. To meet the need of the community, 21 temporary water collection points were installed at various locations around Majuro (see Figure 1.2-3). Water was supplied from the reverse osmosis unit at College of the Marshall Islands and the rainwater reservoirs by MWSC's water trucks to the water collection points.

Source: Post Disaster Needs Assessment of the 2015-2016 Drought

Figure 1.2-3 Typical Temporary Water Collection Point

The education sector was also affected by the drought. The absenteeism of some elementary schools was high, because no water was available for drinking or toilet facilities (see Table 1.2-5).

Table 1.2-5 Absenteeism Rates in the Schools in Majuro

Name of school	Absence rate			Observations
	School year 2014	School year 2015	Increase	
Ajeltake Elementary School	17 %	67 %	50 %	No water
Laura Elementary School	11 %	44 %	33 %	No water
Long Island Elementary School	4 %	9 %	5 %	

Source: Post Disaster Needs Assessment of the 2015-2016 Drought

As described above, restrictions on water use due to the effects of the drought have had a negative impact on various aspects such as the daily lives of the population and the increase in school absenteeism.

(3) Geology

The Team conducted soil investigation at three points in the proposed Project site by drilling. The drilling depth of each investigation point was about 20 m. The result of the investigation shows that the soil of the site proposed for the rainwater reservoir is composed of gravel, gravel sand, etc., which is very solid and does not cause consolidation settlement (see Section 2-2-1-2 (2) for detail).

1-3 Environmental and Social Considerations

1-3-1 Environmental Impact Assessment

1-3-1-1 Project Components having Environmental and Social Impacts

The water supply service for Majuro Atoll is managed by MWSC. Water is supplied from the three WTPs, of which the WTP-C supplying water from the five rainwater reservoirs is the largest. The wall heights of three out of the five rainwater reservoirs were raised between 1986 and 1987 under the Japan's Grant Aid project titled "Majuro Atoll Water Supply Improvement Project"; this contributed to the increase in the storage capacities of the rainwater reservoirs to the current capacity of about 36 MG or 138,000 m^3 including clean water reservoir.

The Project component is the construction of a new reservoir for the above-mentioned WTP-C. The new reservoir is planned to be constructed on an area of about 5.7 ac (2.3 ha) on the ocean-side reef edge between the eastern boundary fence of the Majuro International Airport and the existing rainwater reservoir located at the farthest west to increase the storage capacity of the rainwater reservoir for an

increased water supply (see Figure 2.2-23). Construction sand and stone will be dredged from areas located west of the proposed Project site, which are approved by RMIEPA (see Figure 2.2-33). MWSC will secure a plot located northeast of the proposed Project site as a temporary yard (to be used as contractor office, consultant office, stockyard for construction materials and soil disposal site) which will be managed by the Marshallese government, and the space on the east side of Iakwe Katoj Park will be used temporarily as an access road during the construction period (see Figure 2.2-30).

1-3-1-2 Basic Environmental and Social Conditions

(1) Overview of Basic Environmental and Social Conditions of Project Site

As a basis for the environmental and social considerations study, the outline of the natural environment, pollution and social environment of the Project area is shown in Table 1.3-1.

Table 1.3-1 Overview of Basic Natural Environment, Pollution and Social Environment

Overview	
Natural Environment	
Regional Outline	The Project area is located in Majuro Atoll, which is the capital and largest city of RMI. Majuro Atoll is formed by connecting small, long and narrow islands, with no rivers, lakes or springs; groundwater (as a freshwater lens) can be found only in limited areas, but the main water source of the atoll is rainwater. Majuro Atoll includes seven main villages to which MWSC supplies water. The land area of Majuro Atoll is 3.7 mi^2 (9.7 km^2) and encloses a lagoon of 114 mi^2 (295 km^2).
Climate	The area has a tropical rainforest climate. Temperatures are relatively consistent throughout the year with average temperature of around 81°F (27°C). It has two seasons: a dry season from December to April, and a rainy season from May to November. It receives heavy rainfall throughout the year, and the annual rainfall in 2018 was about 126 in. (3,200 mm). El Nino occurs about every three years to bring about drought. The Northeast Trades predominate from December to April with east or southeast winds blowing for much of the rest of the year.
Topography/ Geology	The narrow land mass island sits atop ancient submerged volcanoes rising from the ocean floor. The topography is mostly flat having an average elevation of about seven ft (2 m) above sea level, and Laura has the highest elevation point estimated at less than 10 ft (3 m) above sea level. The geology of the eastern part of Majuro Atoll consists of a sand layer and gravel-mixed sand layer. In the central area, (about 6 in. or 15 cm) is humus, and it is followed by layers of sand, sand mixed with gravel or gravel mixed with sand. An aquifer exists in the western zone, which consists of calcareous sedimentary layers and limestone. The lagoon and the ocean are composed of coral rocks, and some of them include coral, silt, and pumice.
Protected Areas	Majuro Atoll has 6 protected areas, and all are several kilometers away from the Project area.
Flora & Fauna	The commonly found species in the area are (a) Plants: coconut, breadfruit, banana, pandanus, taro, seaweed, coral; (b) Animals and Fishes: turtles, dolphins, whales, sharks, tuna, sea cucumbers, groupers, wrasses, trochus, butterfly fish, crabs, giant clams, starfishes, frogs; (d) Birds: seabirds, terns, cranes, pigeons, sand pipers ; (e) Insects: snails, fruit flies, mosquitoes, spiders, beetles, ants. On Majuro Atoll, six species of endangered animals and two endemic species can be found.
Pollution	
Air Pollution	Air pollutants are emitted from vehicles driving along the single lane road on Majuro Atoll. However, RMI does not have any air emission standards, and monitoring of air emissions is not conducted. RMIEPA has confirmed that data on air emissions are not available.
Water Pollution	Dredging and filling of reef areas mixed with coral for construction introduce sediments and raises turbidity. The ocean and lagoon are being polluted by sewage and toilet waste directly drained into the waters. Therefore, lagoon waters are highly eutrophic, and this can lead to microalgae infestation. According to RMIEPA, for ocean and lagoon to be safe for swimming and fishing, water must have less than 104 MPN (Most Probable Number) per 100 milliliter (RMIEPA standard) of enterococci contamination, but a sample from Majuro gave a value of 4,100 MPN which is over 40-fold over the safe limit.
Noise & Vibration	Since RMI does not have its own standards for noise and vibration, the standards of the United States Occupational Safety and Health Administration (hereinafter referred to as "USOSHA") are applied when necessary. According to RMIEPA, main sources of the noise and vibration are believed to be traffic and construction activities, but they are below the USOSHA standard of 85 dB. Also, there are no residences or commercial activities around the project site to

	apply any impacts.
Solid Waste Management	The generation rate of solid waste in Majuro was about 35 ton/day in 2017. Solid waste is collected only once a week in the areas between Rita and Woja; but Laura has no collection service and waste must be brought to the transfer station located in Laura and then transferred to the dump site. Collected waste is disposed at the only open dump site located in Rairok. PET bottles and aluminum cans are recycled through a system that adds recycling fees. Use of plastics is prohibited and strictly enforced to gradually reduce the generation of plastic waste.
Soil Contamination	Rainwater soaks directly into the soil and disperses into the saltwater which permeates into the atoll subsoils, but contamination of the soil is not reported.
Social Environment	
Population	The total population of RMI is 58,413 persons (2018 World Bank Census). Majuro Atoll has a population of about 29,000 persons (estimate for 2019, Statistical Yearbook 2017) with a population density of about 3,000 persons/km^2 (7,800 persons/mi^2). The populations of each village in Majuro are, Laura 2,531 persons, Woja 707 persons, Ajeltake 2,551 persons, Rairok 7,110 persons, Delap 8,035 persons, Uliga 2,458 persons, and Rita 6,608 persons (2019 figures calculated from Economic Policy, Planning and Statistics Office (hereinafter referred to as "EPPSO") Water Survey 2010[1] and Statistical Yearbook 2017)
Ethnicity/ Religion	The ethnic groups are Marshallese (92%), mixed Marshallese (6%) and others including Chinese, Koreans, Philippines, Americans, Australians and Japanese (2%) (2006). Marshallese and English are the official languages. Around 75% of the population is Christian. No community is identified as indigenous or ethnic minority community.
Administration	Majuro Atoll consists of seven main villages (formerly islands), namely, Laura, Woja, Ajeltake, Rairok, Delap, Uliga and Rita; each village is headed by one or more Councils, and in total there are12 Councils. Each village is subdivided into Wetos.
Economy	The economy of Majuro is driven mainly by the service sector as well as US financial support. According to the social conditions survey carried out during the project preliminary survey, the median income of survey respondents was USD400/month. According to EPPSO Water Survey 2010, the average annual income is USD13,802. Results of the social conditions survey showed that the occupations of respondents are public employee having the highest response at about 39%, followed by company employee (31%), self-employed (13%), laborer (6%), employer (5%), farmer/fisherman (4%), retired (1%), pastor (1%).
Public Health	Majuro has one main hospital with 101 beds (2017). Further, there are two health centers, three private clinics and five specialized clinics.
Water Supply	MWSC supplies drinking water four hours/day, three times a week during non-drought periods. However, reticulated saltwater is available 24 hours for toilet flushing. Due to low water pressure and insufficient water volume from the MWSC tap, many households have installed rainwater harvesters and some depend on wells.
Sewerage & Sanitation	Domestic wastewater is collected by a sewerage system and without treatment; it terminates at an outfall (which, at the time of the first field survey in 2019, was damaged and needed repair) located at Delap behind the MWSC towards the ocean, with the potential to pollute the marine environment.
Solid waste	Main issues of the solid waste management are increasing solid wastes generation rate, low waste collection rate and unsafe waste disposal.
Electricity	Electricity is supplied 24 hours a day, seven days a week by Marshall Energy Company (hereinafter referred to as "MEC") from two power stations having a total production capacity of 8.5 MW, but power failures sometimes occur. About 88% of the residents receive electricity from the MEC grid. Less than 1% of the residents have generators and over 2 % use solar energy, while others use kerosene, battery or candles.
Transport/Road	The main road of Majuro Atoll is a single 2-lane paved road, which is congested during rush hours.
Education	Public schools in Majuro consist of one university, one college, three high schools and 11 primary schools. Also, there are six private high schools and 10 private elementary schools. Furthermore, two Christian schools teach English.
Cultural Heritage	Majuro Atoll does not have any UNESCO heritage sites, Ramsar wetlands sites or prehistoric sites. However, there are two national parks, one nature reserve and 11 archaeological sites in Majuro Atoll, which are several kilometers away from the Project area.

Source: Republic of the Marshall Islands Environmental Protection Authority (hereinafter referred to as "RMIEPA"), Historic

[1] Majuro and Kwajalein Atoll Household Water Survey Report, 2010, EPPSO

Preservation Office (hereinafter referred to as "HPO"), Marshall Islands Marine Resources Authority (hereinafter referred to as "MIMRA"), CIA Factbook 2019, Statistical Yearbook 2017 and JICA Survey Team

(2) Climate

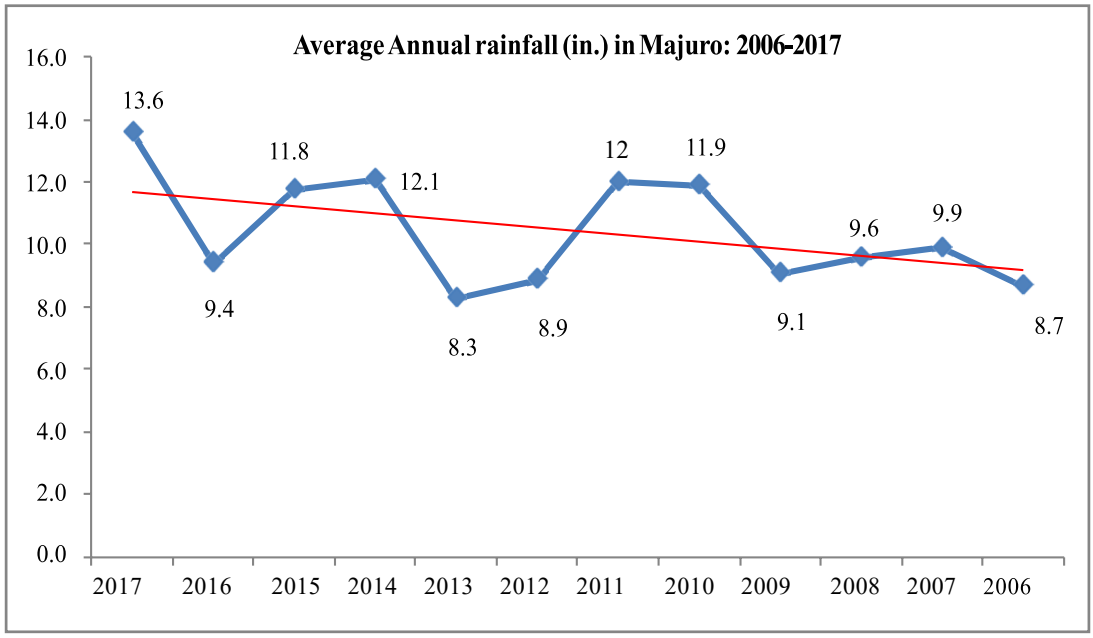
1) Precipitation

Table 1.3-2 shows the monthly and annual rainfall from 2006 to 2017 in Majuro. Figure 1.3-1 shows the rising trend in annual average rainfall from 2006 to 2017 in Majuro.

Table 1.3-2 Monthly Rainfall in Majuro

Year	Annual Average (Inch)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Annual (Inch)
2017	13.6	17.7	9.4	13.1	10.4	4.9	13.0	12.5	13.0	20.9	18.2	10.3	19.6	163.0
2016	9.4	1.1	3.2	11.3	2.1	11.1	7.3	10.1	8.8	13.7	15.3	17.4	11.8	113.1
2015	11.8	8.2	4.3	21.7	15.2	18.1	6.3	9.7	24.2	10.7	10.5	5.3	6.8	141.2
2014	12.1	9.7	12.2	6	23.2	7.6	9.9	22.5	9.6	14.9	11.1	10.8	7.7	145.1
2013	8.3	2.4	10.4	5.1	6.5	6.6	10.6	13	7.6	9.7	9	12.8	5.8	99.6
2012	8.9	8.3	4.5	12.8	9.1	6	8.9	7.5	10.2	7.5	5.8	20.7	6.1	107.3
2011	12	8.1	13.1	15.8	3.2	12.6	10.6	14.6	12.6	12.9	14.7	16	10.4	144.4
2010	11.9	4.9	3.7	9.7	9.4	2.4	20.9	15.8	14.1	19.9	13.2	18.1	11	143.1
2009	9.1	6.3	7	4.1	10.9	5.5	4.5	9.4	8.1	15.2	10.4	11.3	16.8	109.3
2008	9.6	9.5	7.9	6.3	5.3	12.5	9.3	10.1	8.4	8	12.2	14.3	11.8	115.5
2007	9.9	2	4.9	4.3	11.3	11.4	6.7	8.6	7.3	10.3	20.7	20.3	10.9	118.7
2006	8.7	10.5	6.4	6.5	7.3	6.3	11.6	11	9.3	8.7	10.7	8.7	7.7	104.8

Source: Statistical Yearbook 2017



Source: Statistical Yearbook 2017

Figure 1.3-1 Average Annual Rainfall Trend in Majuro

2) Temperature

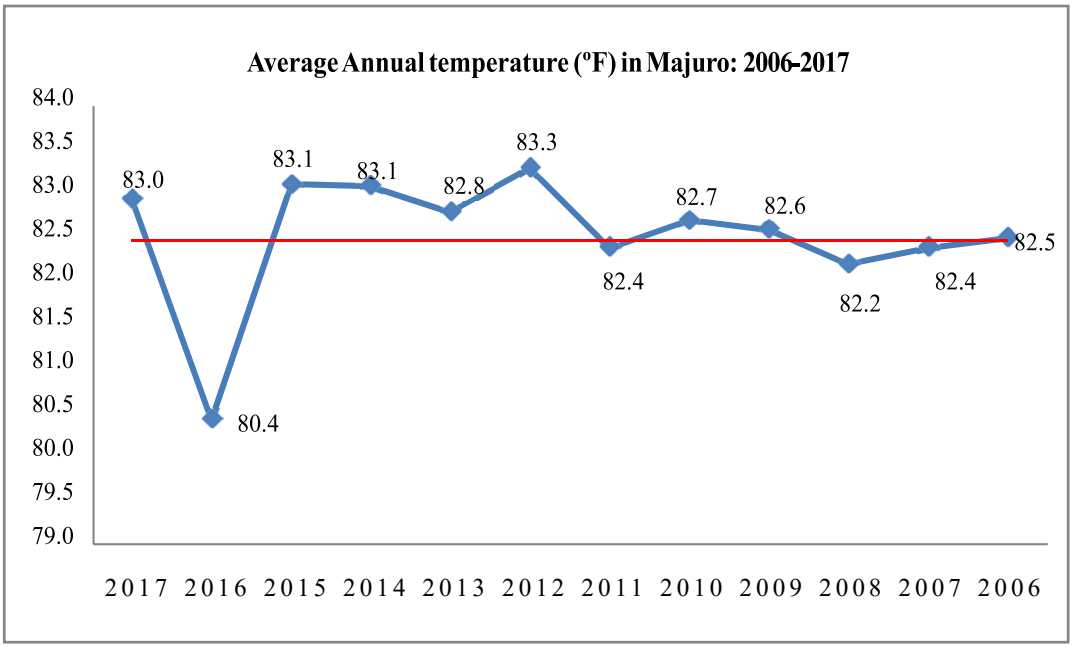
Table 1.3-3 and Figure 1.3-2 show the monthly average temperature from 2006 to 2017 in Majuro.

Table 1.3-3 Monthly Average Temperature in Majuro

Year	Annual Average (ºF)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2017	83.0	82.3	82.6	83.1	82.6	83.6	82.8	82.9	83.5	83.0	83.3	83.1	82.6

Year	Annual Average (°F)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2016	80.4	80.8	80.1	80.6	81.1	80.1	80.8	80.3	81.0	80.9	80.9	79.7	78.9
2015	83.1	82.8	83.2	82.4	82.5	82.8	83.4	83.1	83.2	83.2	83.0	84.1	83.6
2014	83.1	83.1	82.9	83.5	81.8	83.6	83	82.5	83.4	83.5	83.5	83.2	83.5
2013	82.8	83.9	83.2	83	83.1	83.4	82.7	82.7	82.6	82.5	82.9	81.5	82.6
2012	83.3	82	82.4	82.4	82.8	83.6	83.7	83.9	83.2	83.7	84.2	83.2	84
2011	82.4	82.4	81.8	81.8	84.1	82.4	82.8	82.2	82.1	82.5	82	81.8	82.5
2010	82.7	83	82.8	83.2	84	84.2	82.5	82.2	82.6	81.9	81.6	81.7	82.2
2009	82.6	81.9	81.9	82.3	82.5	83.1	83.4	83.2	83.1	83	82.6	81.5	82.6
2008	82.2	82.8	83.4	82.2	82.1	82.1	82	82	81.5	82.5	82	82.1	81.2
2007	82.4	82.3	82	83.2	82.1	82.6	82.7	82.3	82.5	81.9	82.2	82.2	82.7
2006	82.5	81.9	82.4	81.6	82.4	82.5	82.5	82.6	82.7	83.1	83.1	82.6	82.5

Source: Statistical Yearbook 2017

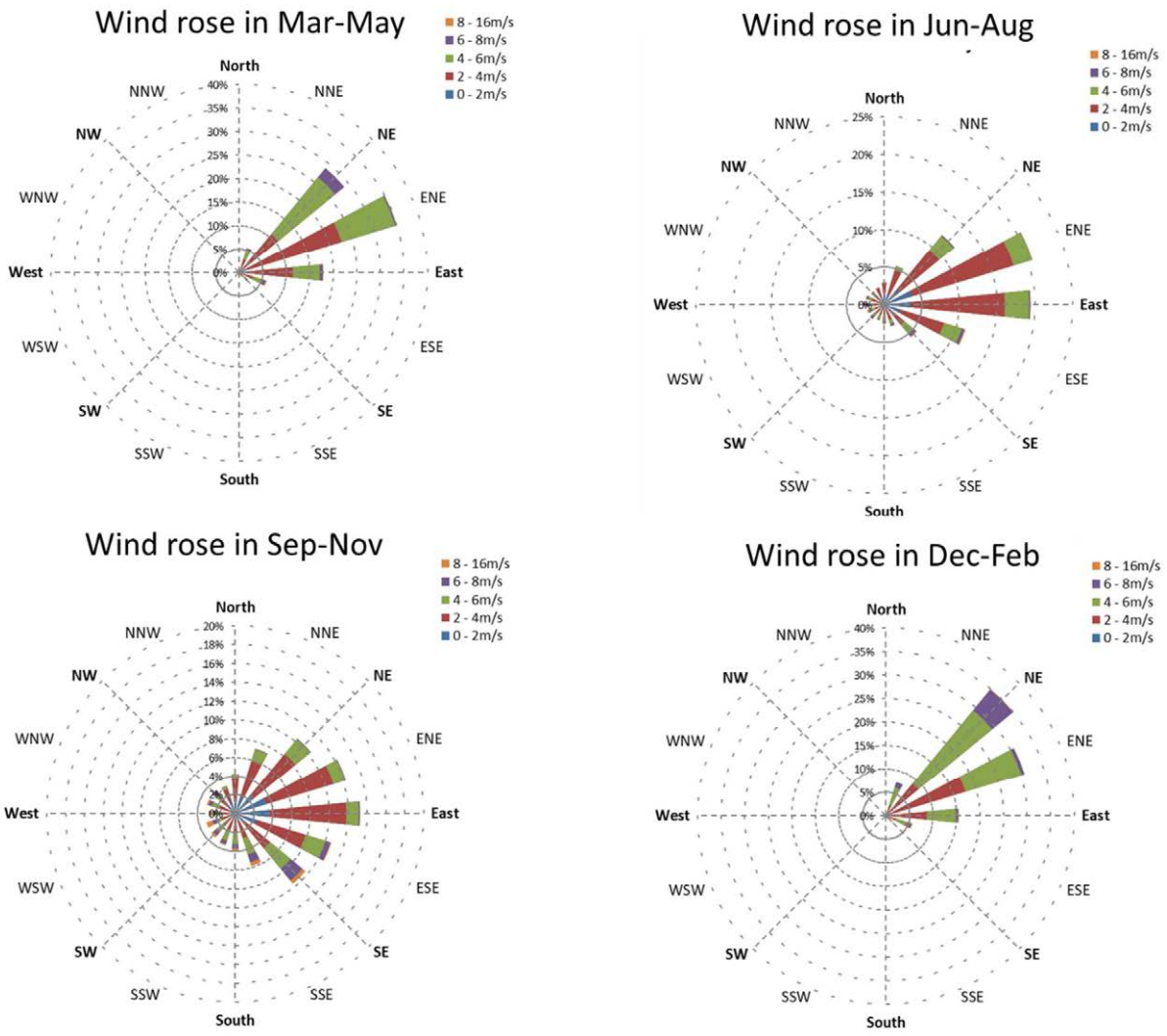


Source: Statistical Yearbook 2017

Figure 1.3-2 Average Annual Temperature in Majuro

3) Wind Speed/Direction

Wind data were collected to examine the construction period and study the seasonal characteristics. Hourly wind data from 2014 to 2018 were collected from the Majuro Meteorological Agency. The maximum wind speed recorded over the last five years was 15.7 m/s. As shown in Figure 1.3-3, the dominant wind directions are NE, ENE, and E. The figure also shows that strong winds with a wind speed of 8-16 m/s come from SE-W from June to November.



Source: JICA Survey Team

Figure 1.3-3 Seasonal Characteristics of Winds in Majuro

(3) Protected Areas of the Project Area

HPO has jurisdiction over the protection and preservation of areas and sites registered for the conservation of nature and cultural heritage in RMI. The protected areas registered around the project area in Majuro Atoll, which is the target area for the survey, are Table 1.3-4.

Table 1.3-4 Protected Areas in Majuro

Protection Category	Protected Area in Majuro	Distance to Project Site
Ramsar Wetlands	None	
UNESCO World Heritage	None	
National Park	● Marshall Islands War Memorial Park ● Peace Park	● 16 mi (26km) ● 9 mi (15km)
Nature Reserve	● Kalalin Pass	● 24 mi (39km)
Protected Area	5 sites (see "5)" below)	● Nearest 10 mi (16km) ● Farthest 37 mi (60km)
Archaeological and Historic Site	11 sites (see "6)" below)	● Nearest 2 mi (3km) ● Farthest 24 mi (39km)

Source: HPO and JICA Survey Team

1) Ramsar Wetlands

Although Ramsar wetland sites are not registered in Majuro Atoll, the following two locations are registered in RMI.

- Jaluit Atoll Conservation Area

  Area: 4.4 mi^2 (11.34 km^2), Year registered: 2004, Distance to Majuro Atoll: 149 mi (240 km)
- Madad Islet of Namdrik Atoll

  Area: 0.015mi^2 (0.04 km^2), Year registered: 2012, Distance to Majuro Atoll: 236 mi (380 km)

2) UNESCO World Heritage Sites

Majuro Atoll does not have any sites registered as a UNESCO World Heritage site, but the Bikini Atoll Nuclear Test Site was registered as a cultural heritage in 2010 which is located about 497 mi (800 km) northwest of Majuro Atoll.

3) National Parks

In Majuro Atoll, the following two locations were registered as national parks to commemorate the end of the war.

- Marshall Islands War Memorial Park, located in Delap village, was registered as a national park in 1976, and is situated about 16 mi (26 km) away from the proposed project site.
- Peace Park constructed by Japan in 1984 on the west side of the international airport in Rairok village was registered as a national park in the same year, and is situated about 9 mi (15 km) away from the proposed project site. A memorial plaque in the park inscribes, “In memory of all those who sacrificed their lives in the islands and seas of the East Pacific during World War II and in dedication to world peace”.

4) Nature Reserves

Kalalin Pass, located northwest offshore from Rita village on the east side of the main island of Majuro Atoll, is designated as a nature reserve, and is situated about 24 mi (39 km) straight linear distance to the proposed project site. Bikini Atoll and Arno Atoll are also registered as nature reserves.

5) Protected Areas

In RMI, 36 locations are registered as protected areas. Among them, the following five locations (total area of about 0.04 mi^2 (0.11 km^2)) are located in Majuro Atoll. The distance to the proposed project site is the linear distance from the protected area to the proposed project site.

- Woja: 37 mi (60 km) to project site
- Bokan Botin: 10 mi (16 km) to project site
- Ene Kalamur: 11 mi (18 km) to project site
- Denmeo: 10 mi (16 km) to project site
- Bikirin: 11 mi (18 km) to project site

6) Archaeological and Historic Sites

Of the 118 prehistoric sites registered in RMI, none of them are located in Majuro Atoll. Also in RMI, 212 sites are registered as archaeologicl or historic sites, and the following 11 sites are located in Majuro Atoll. The distances are linear distances from the archaeological site to the proposed project site.

- Wreckage near Laura: 24 mi (39 km) to project site
- Avenger wreckage near Bokollop Island: 11 mi (18 km) to project site
- “Parking Lot” near Ejit Island: 8 mi (13 km) to project site
- Japanese wharf at Rita: 7 mi (11 km) to project site
- Coca Cola heaven at Rita: 6 mi (10 km) to project site
- US dock at Rita: 6 mi (10 km) to project site
- Marine railway at Uliga: 5 mi (8 km) to project site
- Seaplane ramp at Delap: 4 mi (7 km) to project site
- Mariner seaplane wreckage: 3.7 mi (6 km) to project site
- Duck floatplane wreckage: 2 mi (3 km) to project site
- Val dive bomber site: 21 mi (34 km) to project site

7) Neighbouring Countries

Neighboring countries of RMI are the Federated States of Micronesia to the west, Wake Island (United

States) to the north, the Republic of Kiribati to the southeast, and the Republic of Nauru to the south. Boundaries with these countries are all in the ocean and the islands are located over 620 mi away. Therefore, it can be assumed that safety measures for the project site against the neighboring countries are not needed.

From the above results, it can be assumed that protected areas will not receive any impacts when the rainwater reservoir is constructed in this Project.

(4) Ecologically Important Fauns and Flora

MIMRA is the organization responsible for endangered and threatened species of fauna and flora in RMI. MIMRA classifies fauna and flora into nine categories in conformity with the International Union for Conservation of Nature (IUCN) Red List. According to the IUCN Red List of March 2019, as shown in Table 1.3-5, extinct and critically endangered fauna are not classified in RMI. However, a total 101 species of fauna are classified as endangered and vulnerable, and 122 species of animals are classified as lower risk, and therefore, cautions are needed to avoid harming them during the construction period as explained below. On the other hand, no flora are listed under the categories of extinct, threatened and lower risk, but 25 flora species are classified as not evaluated, and during construction, these must not be harmed.

Table 1.3-5 Marshall Islands IUCN Red List

Major Category	Sub-Category	Fauna	Flora
Extinct	Extinct	None	None
	Extinct in the Wild	None	None
Threatened	Critically Endangered	None	None
	Endangered	10	None
	Vulnerable	91	None
Lower Risk	Near Threatened	119	None
	Least Concern	3	None
Others	Data Deficient	65	None
	Not Evaluated	1,196	25

Source: JICA Survey Team

As mentioned above, there are no extinct species in RMI, but out of the 101 fauna categorized as threatened, the six species shown in Table 1.3-6 are found in Majuro Atoll. Of these, the Micronesian pigeon is designated as endemic in the Pacific region. Also endemic to Majuro are the three-banded anemonefish and longhorn beetle, but are not designated as threatened species. These species also need to be cautioned to avoid any harm to them.

Table 1.3-6 Threatened Species found in Majuro

Category	Name
Seashell	Giant clam (Tridacna gigas)
Turtle	Green sea turtle
	Hawksbill sea turtle
Fish	Napoleon wrasse
	Bumphead parrotfish
Bird	Micronesian pigeon

Source: MIMRA and JICA Survey Team

If a threatened species appears at the construction site of the rainwater reservoir, measures such as driving them away or removing them to a safer place will be taken not to cause any harm to them.

1-3-1-3 Institutional Structure for Environmental and Social Consideration in the Marshall Islands

(1) Laws and Regulations related to Environmental and Social Consideration

Due to concerns on the negative environmental impacts of urbanization in RMI, the Marshallese government enacted the National Environmental Protection Act in 1984 to address environmental protection and resource management. Table 1.3-7 shows the laws and regulations, as well as high level

plans and strategies for environmental and social considerations in RMI.

Table 1.3-7 Acts and Regulations related to Environmental and Social Consideration

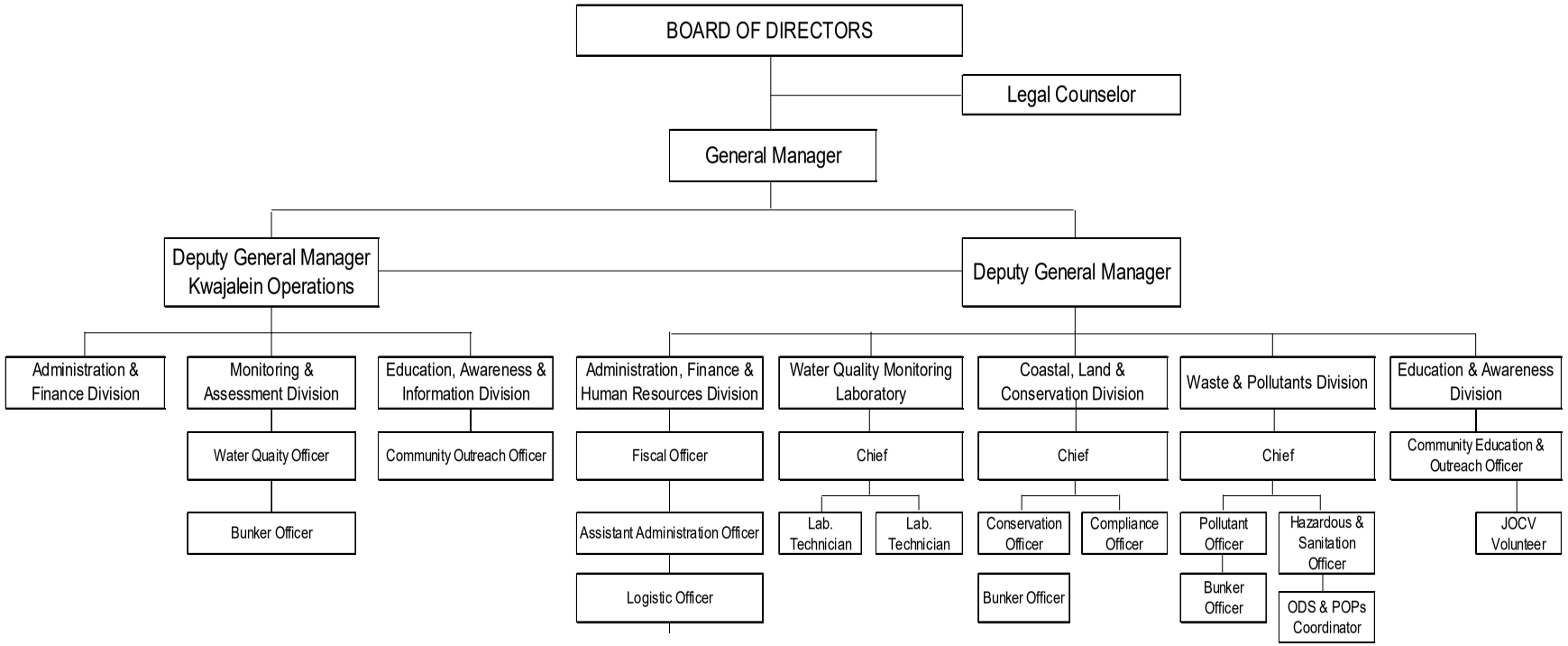
Category	Act, Regulation
High level document	● Constitution of the Marshall Islands 2005 ● RMI National Environmental management Strategy 2017-2022 ● Marshall Islands Agenda 2020 ● Tile Til Eo 2050 Climate Strategy 2018 ● National Water and Sanitation Policy 2014
Environmental protection	● National Environmental Protection Act 1984 ● National Environmental Protection (Amendment) Act 2016 ● Office of Environmental Planning and Policy Coordination Act 2003 ● Earthmoving Regulations 1989 ● Environmental Impact Assessment Regulations 1994
Water supply and wastewater	● Public Water Supply Regulations 1994 ● Toilet Facilities and Sewage Disposal Regulations 1990
Solid waste	● Solid Waste Regulations 1989
Hazardous materials	● Ozone Layer Protection Regulations 2004 ● Pesticides and Persistent Organic Pollutants Regulations 2004
Coastal conservation and marine resources protection	● Coast Conservation Act 1988 ● Civil Liability for Oil Pollution Damage Act 1993 ● Maritime Administration Act 1990 ● Marine Zones (Declaration) Act 1984 ● Marshall Islands Marine Resources Authority Act 1997 ● Marine Mammal Protection Act 1990 ● Marine Water Quality Regulations 1992
Fauna and flora protection	● Endangered Species Act 1975 ● Quarantine Restrictions Act 1966
Protected areas and heritage sites	● Historic Preservation Act 1991 ● Protected Areas Network Act 2015
Land related	● Planning and Zoning Act 1987 ● Land Acquisition Act 1986 ● Public Lands and Resources Act 1966
Public health and food safety	● Public Health, Safety and Welfare Act 1966 ● Food Safety Act 2010
Fisheries	● Fisheries Act 1997 ● Fisheries Enforcement Act 1997 ● Tuna and Game-Fish Conservation Zone Act 1996 ● Marshall Islands Fisheries Regulations 1998
Disaster	● Disaster Assistance Act 1987

Source: RMIEPA and JICA Survey Team

(2) Related Organizations

RMIEPA was established by the National Environmental Protection Act as the organization to manage environmental and social considerations of RMI. The main responsibilities are improvement and protection of the environment, as well as approval of project permits and EIA. The organization chart of RMIEPA is shown in Figure 1.3-4.

ODS: Ozone depleting substances
POPs: Persistent organic pollutants
JOCV: Japan Oversesa Cooperatin volunteers



Source: RMIEPA and JICA Survey Team

Figure 1.3-4 Organization Chart of RMIEPA

The roles of each division of RMIEPA are shown in Table 1.3-8.

Table 1.3-8 Roles of RMIEPA Divisions

Division	Roles and Responsibilities
Administration, Finance & Human Resources Division	● Financial Policies and Procedures ● Personnel Policies ● Employment Handbook ● In-house Rules and Policies ● Procurement Code ● Strategic Plan ● Performance Based Budget Portfolio
Water Quality Monitoring Laboratory	● Marine Water Quality Regulations 1992 ● Public Water Supply Regulations 1994 ● Toilet Facilities and Sewage Disposal Regulations 1990
Coastal, Land & Conservation Division	● Earthmoving Regulations 1998 ● Environmental Impact Assessment Regulations 1994 ● Coastal Management Framework 2008 ● Conservation Activities
Waste & Pollutants Division	● Solid Waste Regulations 1989 ● Pesticides and Persistent Organic Pollutants Regulations 2004 ● Ozone Layer Protection Regulations 2004 ● Mercury Activities
Education & Awareness Division	● Environmental Education Guidelines ● Education Awareness Raising ● Information Center ● Outer Islands Communication Center ● Technical Support

Source: RMIEPA and JICA Survey Team

Organizations related to environmental and social considerations other than RMIEPA are listed in Table 1.3-9.

Table 1.3-9 Other Organizations Related to Environmental and Social Consideration

Organization	Roles and Responsibilities
HPO	Any major development project considered for EIA can be implemented only upon receiving a permit from this office confirming that no protected, heritage or historical sites exist in the project area.
MIMRA	Vital for environmental oversight and assuring sustainability of marine operations.
Office of Environmental Policy, Planning and Coordination (OEPPC)	Central agency for programming international environmental treaties and resulting funding, and assist EPA in finding funding partners and possibilities to ensure the programs' long-term sustainability.
EPPSO	Develop local planning programs of local governments for large scale environmental planning and coordinate local planning ordinances to improve environmental quality

Source: RMIEPA and JICA Survey Team

(3) Environmental and Social Consideration Process of RMI

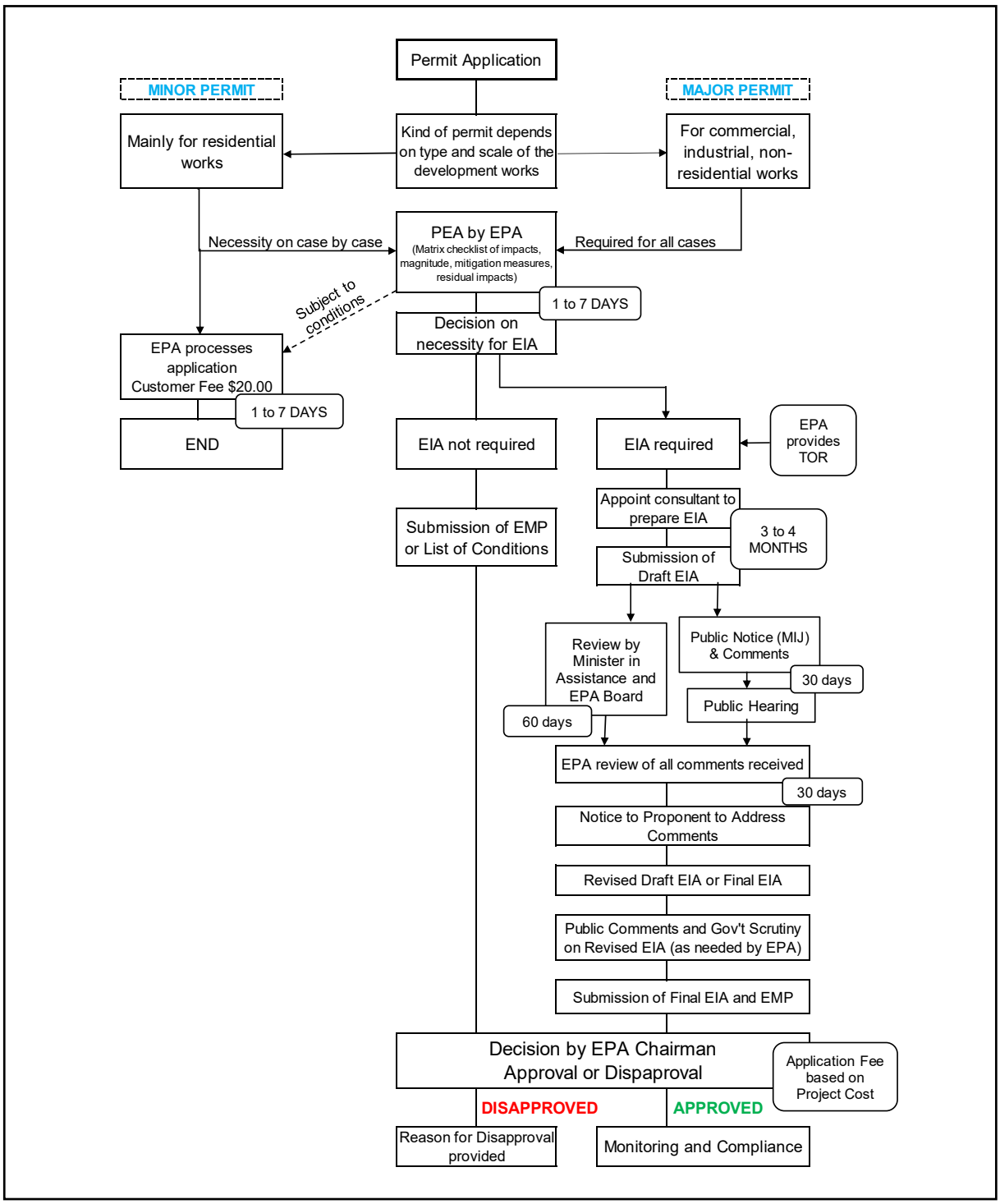
The process for receiving approval to implement projects differs between small scale projects and large scale ones. Small scale works apply to housing construction, water supply and sewerage connections, septic tank installation and similar works, while any other works are considered as large scale works. RMIEPA has confirmed that this project is considered as a large scale project. Whether an EIA is required or not is decided after MWSC submits an Earthmoving Permit Application[2] to RMIEPA and depending on the results of the Preliminary Environmental Assessment (hereinafter referred to as "PEA") carried out by RMIEPA. In the PEA, environmental and social impacts divided into 35 parameters listed below are evaluated by five ratings (negligible, low, medium, high, very high), and if more than half of the parameters receive the top two ratings (high and very high), then EIA is required,

[2] A Land Modification Permit from HPO confirming that protected, historic or heritage sites do not exist must be submitted with the Earthmoving Permit Application.

but the final decision is made by the General Manager of RMIEPA.

1. Geology
2. Coastal Processes
3. Coastal Geomorphology
4. Marine Hydrodynamics
5. Terrestrial Flora and Fauna
6. Intertidal Marine Flora and Fauna
7. Subtidal Marine Flora and Fauna
8. Endangered/Threatened Species
9. Source of Construction/Aggregate/ Fill Materials
10. Demand on Limited Resources
11. Contaminated Land
12. Marine Water Quality
13. Fresh Water Quality
14. Solid Waste
15. Hazardous Waste
16. Waste Water
17. Air quality
18. Climate Change
19. Disaster Risk Management
20. Noise and Vibration
21. Landscape and Visual Amenities
22. Marine Navigation
23. Land Transport
24. Community and Occupational Health and Safety
25. Impacts on Nearby Development and/or Communities
26. Quality and Distribution of Local Employment
27. Local and National Tax Revenue or Fees
28. Demands on Government and Community Services
29. National and Local Environmental Plans
30. Access to and Quality of Recreational Activities
31. Density and Distribution of Population and Housing
32. Existing Sources of Other Development Impacts
33. Traditional Landowner Consent
34. Cultural Heritage and Archaeology
35. Culture and Tradition

The procedure for permit application from RMIEPA to implement projects is shown in Figure 1.3-5.



Source: Prepared by JICA Survey Team based on information from RMIEPA

Figure 1.3-5 Flow Chart of Project Implementation Permit Approval

(4) Gap Analysis related to EIA

The procedures for environmental and social considerations in RMI are in accordance with the Environmental Impact Assessment Regulations 1994 (EIAR). Table 1.3-10 show the comparison and gaps between RMI regulations and JICA Environmental Guidelines (JICA GL).

Table 1.3-10 Gap Analysis

Item	JICA Environmental Guidelines (JICA GL)	Marshallese Regulations	Gaps / Countermeasures
Underlying Principles	Environmental impacts that may be caused by projects must be	These Regulations are designed to integrate the EIA process into early planning of projects to	The JICA guidelines and

Item	JICA Environmental Guidelines (JICA GL)	Marshallese Regulations	Gaps / Countermeasures
	assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan. (JICA GL p. 28)	ensure consideration of environmental factors and to avoid delays, as well as to identify at an early stage the significant environmental facing the Republic.(EIAR, Part I, 2. b)	Marshallese regulations both mention the need for environmental consideration at an early stage, but EIA is not needed for the Project.
Information disclosure and stakeholder consultation	•EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them. •EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted. (JICS GL, p.32) •For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans. (JICA GL, p. 29) •In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared; •Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared; (JICA GL, p. 32)	At any time during the EIA process, the Authority may convene a public hearing or hearings for the purpose of facilitating public involvement in the EIA process. Adequate notice of the hearing or hearings, adequate opportunity to appear and be heard, and adequate opportunity to provide written comment, shall be given to all interested persons. (EIAR, Part V, 27)	Stakeholders meetings or public hearings are requirements for both JICA guidelines and Marshallese regulations. However, EIA is not needed for this project.
Impact to be assessed	The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural	"Significant effect" means an important, meaningful, or serious impact on the environment, either in the context of the setting of the proposed development activity, or in the context of the intensity of the proposed development activity's	The impacts to be assessed by the Marshallese regulations do not include social

Item	JICA Environmental Guidelines (JICA GL)	Marshallese Regulations	Gaps / Countermeasures
	environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. (JICA GL, p. 28) In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project. (JICA GL, p. 29)	effect on the environment. Criteria for determining significance include, but are not limited to: (i) the degree to which public health and safety are affected; (ii) the degree to which the unique characteristics of the geographic area are affected; (iii) the degree to which effects on the environment are likely to involve controversy; (iv) the degree to which unique or unknown risks are taken; (v) the degree to which a precedent for future action is made; (vi) the potential for cumulative environmental impacts; (vii) the degree to which the natural functioning of the ecosystem is likely to be inhibited; (viii) the degree to which a cultural, natural, scientific, or historic resource may be threatened; (ix) the potential to threaten the existence of rare or endangered species, or their critical habitats; (x) the degree to which fish and wildlife resources of ecological, commercial, subsistence, and recreational importance are jeopardized; and (xi) the extent to which one use of a resource may be incompatible with another use of that resource. (EIAR, Part I, 4. s) An EIA, as part of the EIA process, shall include an assessment of the full proposed development activity, including, but not limited to, planning, acquisition, development, construction, operational and decommissioning phases of the proposed activity. (EIAR, Part III, 10. b) Each EIA shall contain a summary of the proposed development activity and its consequences in simple, straightforward and accurate language. The summary shall stress the major conclusions, areas of controversy, the issues to be resolved, the choice among alternatives, and how to mitigate the significant impacts. (EIAR, Part IV, 19)	impacts such as involuntary resettlement and socially vulnerable people. In RMI, resettlement is rare and socially vulnerable people are not given attention. Also, ethnic minority and indigenous people are not found in RMI. Therefore, Marshallese regulations will be applied.
Monitoring and Grievance handling	Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders. (JICA GL p. 31) When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems. (JICA GL, p. 31)	Upon initiation of the construction of an approved development activity, the Authority, the proponent, and other person as requested, shall monitor the progress of construction. (EIAR, Part VI, 36) After completion of construction of an approved development activity, or during the operational phase of such an activity, or both, the Authority may require the proponent to furnish an independent examination and report, called an environmental audit. The environmental audit shall: (i) describe the actual environmental effects of the completed activity; (ii) identify those impacts inadequately or inaccurately addressed in the EIA; and (iii) recommend corrective action as required. (EIAR, Part VI, 37) Adequate notice of the hearing, and an adequate opportunity to appear and be heard at the hearing, shall be given to all interested persons. (EIAR, Part VII, 41, b)	Both the JICA guidelines and Marshallese regulations are required to submit the results of the monitoring with opportunity for stakeholders to give grievances and opinions. Therefore, Marshallese regulations will be applied.
Ecosystem	Projects must not involve	Under the definition of "Significant effect":	Marshallese

Item	JICA Environmental Guidelines (JICA GL)	Marshallese Regulations	Gaps / Countermeasures
and Biota	significant conversion or significant degradation of critical natural habitats and critical forests. (JICA GL, p. 30)	(vii) the degree to which the natural functioning of the ecosystem is likely to be inhibited; (viii) the degree to which a cultural, natural, scientific, or historic resource may be threatened; (ix) the potential to threaten the existence of rare or endangered species, or their critical habitats; (x) the degree to which fish and wildlife resources of ecological, commercial, subsistence, and recreational importance are jeopardized; and (xi) the extent to which one use of a resource may be incompatible with another use of that resource. (EIAR, Part I, 4. s)	regulations will be applied since it gives concern to the natural environment.
Indigenous People	Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses. (JICA GL, p. 30)	There are no indigenous people residing in RMI	In Marshall Islands, indigenous people do not need to be considered

Source: RMIEPA, EIAR and JICA Survey Team

1-3-1-4 Comparison of Alternative Options (Including Without-Project-Scenario)

Alternative plans, including a no project case (without-project-scenario), are compared and evaluated as shown in Table 1.3-11.

Table 1.3-11 Comparison of Alternative Water Sources

Alternative Water Facilities	Advantages	Disadvantages	Results	Evaluation
Without Project Scenario: Existing facilities	✓ Additional cost is not required ✓ Land acquisition is not required ✓ Environmental impacts are not expected	✓ Water supply improvement is difficult ✓ Water supply is limited during normal periods, and is limited, especially during droughts and disasters	Present water supply issues cannot be improved	Low
Rainwater: Airport catchment and reservoir storage	✓ Continuous water supply is possible ✓ Water supply during droughts and disasters can be guaranteed ✓ It can increase water service customers ✓ It can increase service hours due to increase in availability of water ✓ Operation and maintenance becomes easy	✓ Land reclamation for reservoir construction is necessary ✓ Construction cost can rise ✓ Marine environment can be affected	The present reservoir capacity increases as a counter measure for droughts	High
Groundwater: Well pumping	✓ Fresh water can be supplied ✓ Continuous water supply is possible ✓ It can increase water supply population ✓ Construction work is limited to a small area	✓ Groundwater is available only in a limited area (mainly in Laura village) ✓ Pump groundwater up to storage tank is necessary ✓ Power supply for the pumps is necessary ✓ Groundwater source is scarce since only lens can	Due to limited catchment area and water pumping restrictions, it should be used only during emergencies such as droughts	Medium

Alternative Water Facilities	Advantages	Disadvantages	Results	Evaluation
		be used ✓ Excessive pumping of groundwater can cause lens coning leading to a possibility of pumping up saltwater ✓ Due to limited pumping capacity, pump use may become limited during droughts and disasters		
Seawater: Desalination facilities	✓ Water source is abundant ✓ Water supply during droughts and disasters can be guaranteed ✓ It can increase water service customers ✓ It can increase service hours due to increase in water volume ✓ Construction period is short ✓ It requires a small space for desalination facilities	✓ Operation and maintenance cost can rise due to chemical cleaning of membrane and replacement of membrane ✓ It needs to hire staff for operation and maintenance of automation of desalination facilities ✓ Highly chlorinated effluent can affect the marine environment	Since staff or outsourcing is required for operation and maintenance of automation of desalination facilities, this is not an appropriate technology	Low
Bottled water: Mainly imported	✓ Water quality is stable and safe ✓ It can be easily purchased	✓ It has to bought from a store or delivered ✓ It may be sold out and out of stock ✓ It is unit price is higher than that of other water supply options, and not suitable for large quantity consumption ✓ Empty bottles need to be disposed	Since its cost is comparatively high, this option is appropriate for drinking only	Low

Source: MWSC and JICA Survey Team

From the above consideration, rainwater was selected as the most optimal water source for the Project. Next, three alternative types of reservoir structures are compared as shown in Table 1.3-12. Refer to Section "2-2-2-2 (1)" for explanation of the results.

Table 1.3-12 Comparison of Alternative Reservoir Structures

Item	Option 1	Option 2	Option 3
Structure	Embankment + inverted T-retaining wall (same as the existing rainwater reservoir)	Inverted T-retaining wall	Rectangular tank
Reservoir capacity	15.2 MG (57.536 m^3)	17.8 MG (67,541 m^3)	15.8 MG (59,765 m^3)
Reinforced concrete ratio	1.0	6.4	44.5
Embankment ratio	1.0	1.1	1.1
Lining sheet ratio	1.0	1.1	None
Water tightness	Good	Good	Very good
Workability	Short construction period	Long construction period	Very long construction period
Construction cost ratio	1.0	2.7	17.4
Economy	Least expensive	Uneconomical	Uneconomical
Environmental impact	・Temporary exhaust gas ・Temporary noise and vibration ・Temporary turbid water ・Little construction waste	・Temporary exhaust gas ・Temporary noise and vibration ・Temporary turbid water ・Some construction waste	・Temporary exhaust gas ・Temporary noise and vibration ・Temporary turbid water ・Large amount of construction waste
Social impact	・Temporary traffic jams	・Temporary traffic jams	・Temporary traffic jams

Item	Option 1	Option 2	Option 3
	・Employment opportunities during construction ・Impact on landscape	・Employment opportunities during construction ・Impact on landscape	・Employment opportunities during construction ・Impact on landscape
Overall Evaluation	**High**	**Medium**	**Low**

Source: JICA Survey Team

1-3-1-5 Scoping and TOR for Environmental and Social Considerations Study

(1) Scoping

Results of the scoping made on impact items thought to be important for environmental and social considerations are shown in Table 1.3-13. Information needed for the evaluation was collected in different ways including interviews with relevant organizations, and field surveys.

Table 1.3-13 Scoping

Item		Rating			Reasons
		PLA	CON	OPE	
Pollution Control					
1	Air Pollution	D	B-	D	CON: Small-scale air pollutants can be discharged by vehicles and construction machineries during construction.
2	Water Pollution	D	B-	D	CON: Waste generated by construction works can cause water turbidity.
3	Solid Waste	D	B-	C	CON: Constriction debris and surplus soil will be generated during construction. OPE: Some sedimentation sand can be generated during operation.
4	Soil Contamination	D	D	D	Since substances which can contaminate soil are not generated, there is no possibility of soil contamination.
5	Noise & Vibration	D	B-	C	CON: Noise and vibration will be generated by operating construction machineries. OPE: Operating pumps may generate some noise and vibration.
6	Ground Subsidence	D	D	D	Dredging will not cause ground subsidence, and there will be no groundwater extraction.
7	Offensive Odor	D	D	D-	Offensive odor will not be generated.
8	Bottom Sediments	D	C	D	Since there are no lakes or rivers in Majuro, bottom sediments will not be affected. However, dredging, excavation and filling might have impact on bottom sediments.
Natural Environment					
9	Protected Areas	D	D	D	There are no protected areas in the Project area.
10	Ecosystem	D	B-	D	CON: The construction works may have some impact on marine flora and fauna, particularly, in the Project area to be dredged, excavated and filled.
11	Hydrological Situation	D	D	D	No hydrological impact is expected because no surface water intake or groundwater extraction is involved.
12	Topography & Geological Features	D	B-	D	CON: Changes in topographic conditions below the ocean surface will occur due to dredging, excavation and filling work during the construction.
Social Environment					
13	Land Acquisition & Involuntary Resettlement	D	D	D	There will be no resettlement as the Project site is an uninhabited area which is submerged during high tide and leased by the government (see Appendix-5 for list of documents related to the lease).
14	The Poor	D	D	D	Since the poor are not living around the project site, impact on the poor is not expected.
15	Ethnic Minorities and Indigenous People	D	D	D	There are no ethnic minorities or indigenous people living in or around the Project site. .
16	Local Economy such as Employment, Livelihood	D	B+	B+	CON: Positive impact is expected through employment of local laborers during construction. OPE: Water supply period can be extended during emergencies such as droughts to improve health and livelihood.
17	Land Use and Utilization of Local Resources	D	B-	D	CON Construction of the rainwater reservoir on an open space, which is submerged during high tide, can change the land use rom a recreational area such as for swimming to a public works area. OPE: Operation of the rainwater reservoir can develop the economic and social

Item		Rating			Reasons
		PLA	CON	OPE	
					conditions of the area to especially improve water supply conditions during emergencies such as droughts.
18	Water Usage	D	D	D	CON: Water is used temporarily for washing and cleaning in a minimum amount.
19	Existing Social Infrastructures & Services	D	B-	D	CON: Traffic jams can occur during construction.
20	Social Institutions such as Local Decision-Making Institutions	C	D	D	PLA: The lease renewal for the proposed project site is already agreed, but final agreement on the lease price is needed. Refer to Item No. 2 in the table of Appendix-5. CON/OPE: Social institutions do not exist around the proposed project area.
21	Misdistribution of Benefits and Damage	C	D	D	PLA: Landowners of the project site will receive lease benefits which the non-landowner cannot receive.
22	Local Conflicts of Interest	C	D	D	PLA: If the lease price for use of the proposed land is different from other lease costs, this may cause conflict of interest.
23	Landscape	D	C	D	CON: The construction work might cause minor and temporary impact on the landscape. OPE: The large reservoir might change the landscape of the neighboring area, but there are no residences in the neighboring area.
24	Cultural Heritage	D	D	D	Since no cultural heritage sites are found in the area around the Project site, no impact is expected.
25	Gender	D	D	D	Impact on gender is not expected.
26	Child Rights	D	D	D	Impact on children is not expected.
27	Infectious Diseases such as HIV/AIDS	D	C	C	CON: The inflow of worker may increase the risk of the spread of infectious diseases, but the risk may be reduced through appropriate health and hygiene training. OPE: Infectious diseases such as malaria may spread due to the breeding of mosquitos at the rainwater reservoir during operation.
28	Working Conditions	D	C	C	CON/OPE: Workers' health and safety are ensured during construction and operation under the USOSHA regulations.
Others					
29	Accidents	D	B-	C	CON: Precautions should be taken against traffic jam and/or accidents during construction. OPE: Accidents such as falling from the rainwater reservoir may occur during operation.
30	Trans-boundary & Climate Change	D	D	D	Since the Project site is located in the atoll, no trans-boundary impact is expected. Also, the scale of construction and operation is not large enough to affect global warming.

Notes:
1) Phase of Activity: PLA: During planning & preparation, CON: During construction, OPE: During operation
2) Rating: A+/-: Significant positive/negative impact is expected, B+/-: Positive/negative impact is expected to some extent, C: Extent of impact is unknown (A further examination is needed, and the impact could be clarified as the study progresses), D: No impact is expected
Source: RMIEPA and JICA Study Team

(2) TOR for Environmental and Social Considerations Study

The terms of reference for the environmental and social considerations study are listed in Table 1.3-14.

Table 1.3-14 TOR for Environmental and Social Consideration Study

Environmental Item	Survey Item	Survey Method
Alternative Option Consideration	● Consideration of reservoir structure	● Amount of construction waste, comparison of environmental and social impacts
Air Pollution	● Identification of present air quality (exhaust gas and dust) ● Impacts during construction	● Existing information analysis and field measurements as necessary ● Confirmation of work items, methods, period, locations, extent, types of construction equipment, working locations, vehicle number/use period/route
Water Pollution	● Marine water quality (turbidity, pH, EC, COD, oil, Enterococci)	● Investigation of existing information, collection of information from relevant organizations
Solid Waste	● Disposal method of construction	● Inquiries to relevant organizations, study of similar

Environmental Item	Survey Item	Survey Method
	waste	cases
Noise and Vibration	● Impacts during construction	● Confirmation of work items, methods, period, extent, types of construction equipment, working locations, vehicle number/use period/route
Bottom Sediments	● Type of soil	● Existing information analysis and field inspection as necessary
Ecosystem	● Existence of rare species	● Investigation of existing information, collection of information from relevant organizations
Land Acquisition	● Final agreement with landowners of proposed construction site	● Confirmation with relevant government offices
Existing Social Infrastructure & Services	● Traffic jams during construction	● Confirmation with local institutions and field survey
Infectious Diseases such as HIV/AIDS	● HIV/AIDS disease rate around project site	● Existing information analysis and inquiries to relevant institutions
Working Conditions including Work Safety	● Occupational safety measure	● Related information analysis
Accidents	● Traffic accidents	● Existing information analysis and field survey
Stakeholders Meeting	● Hold meetings	● Interviews with related organizations before commencement of construction

Source: RMIEPA and JICA Survey Team

1-3-1-6 Results of Environmental and Social Considerations Study

The results of environmental and social considerations study based on the above TOR are shown in Table 1.3-15. During construction, a strict plan is needed to ensure minimize impacts on the surrounding residential area, ocean and lagoon (see Section "1-3-1-7").

Table 1.3-15 Results of Environmental and Social Considerations Study

Environmental Item	Result
Alternative Option Consideration	After comparing the three options in terms of workability, and other factors, it was found that the embankment + inverted T-retaining wall structure, which is the same structure as the existing rainwater reservoir, had the highest evaluation.
Air Pollution	Small-scale air pollutants might be discharged temporarily by vehicles and construction machineries as well as dust during construction.
Water Pollution	Turbid wastewater generated by construction works can cause water to become contaminated. Since data on turbidity, pH, EC, COD, oil and Enterococci are not available, these parameters should be measured before construction as baseline data.
Solid Waste Solid Waste	Minimum amounts of surplus soil will be generated during construction works, but it will be used for back-filling. Also, minimum amounts of construction debris will be generated at the construction site which will be disposed at the disposal site designated by RMIEPA. Operation of the rainwater reservoir can generate sedimentation sand.
Noise and Vibration	Noise and vibration will be generated by operating construction machineries during construction. In addition, there is a possibility of some noise/vibration generated by operating pumps during operation.
Bottom Sediments	Dredging, excavation and filling during construction might have some impact on bottom sediments
Ecosystem	Construction works may have some impact on the marine ecosystem such as coral reefs where the project area will be dredged, excavated and filled.
Land Acquisition	Agreement on land lease renewal was made (Refer to Appendix-5).
Existing Social Infrastructures & Services	Traffic jams can occur and traffic control or restriction will be required.
Infectious Diseases such as HIV/AIDS	There is a risk of spreading infectious diseases during construction. Also, there is the risk of infectious diseases by mosquito breeding in the rainwater reservoirs during operation.
Working Conditions including Work Safety	Working conditions are protected and assured by USOSHA regulations.
Accidents	Traffic jams and/or accidents need to be cautioned during construction. There is the risk of accidents such as falling from rainwater reservoirs during operation.
Stakeholders Meeting	Stakeholders meetings were held (see Section "1-3-1-11"), but if necessary, another meeting will be held.
Quarry and Sand Mining*	• Excavation of the existing quarries and sand pits was already approved by RMIEPA even

Environmental Item	Result
	if the excavation amount for this project is included, and was confirmed to be environmentally safe. Therefore, since RMIEPA has approved this excavation, MWSC will make an application for this activity at the start of the project • Since quarrying and sand mining have been implemented in many areas, there would be no further environmental impact due to disturbing of sand drift. However, it is necessary to examine if there is any additional impact on the existing mining pits due to the amount of coral rock and sand required for construction of the revetment and rainwater reservoir. • As for quarrying at the ocean side, because coral inhabit at the reef edge, coral rock excavation should be conducted at a certain distance from the reef edge. In addition, silt fences are required to avoid the impact on coral during excavation. • As for sand mining, in order to mitigate environmental impacts, sand bars between the islands in the northern part of Majuro Atoll (around Eneko Island) could be possible as sources for construction materials.
Coastal Erosion*	According to the National Institute for Environmental Studies in Japan, since the project site is surrounded by coral reef, the sand drift along the project site is considered to be naturally small. In addition, the revetment and the rainwater reservoir are located inside the reef area which cannot disturb the shore line sand drift. Therefore, there is no impact from erosion on surrounding coastlines due to the construction of the revetment and rainwater reservoir.

Note: * Interview with National Institute for Environmental Studies in Japan
Source: RMIEPA and JICA Survey Team

1-3-1-7 Impact Evaluation

Based on results of the environmental and social consideration study, the evaluation results are shown in Table 1.3-16.

Table 1.3-16 Evaluation Results

Item	Rating during Scoping			Rating based on Survey			Reason
	PLA	CON	OPE	PLA	CON	OPE	
Air Pollution	D	B-	D	D	B-	D	CON: Air pollution will be reduced through laborers'/drivers' education, periodic vehicle maintenance, keeping within the speed limit, working time control and periodic water spraying on dusty soils.
Water Pollution	D	B-	D	D	B-	D	CON: Measures such as silt fence, and construction methods, which can minimize outflow of polluted water, should be used.
Solid Waste	D	B-	D	D	B-	D	CON: Construction workers will be guided not to leave surplus soil and construction debris at the construction sites. RMIEPA has indicated the existing waste disposal site where construction waste and debris can be disposed.
Noise & Vibration	D	B-	C	D	B-	D	CON: Noise and vibration will be reduced through education to laborers/drivers and controlling the speed limit and working time. OPE: To minimize noise and vibration, the pumps and generators will be installed inside a building with standard structure, and therefore the impacts of noise and vibration will be minimal, but there are not residences nearby.
Bottom Sediments	D	D	D	D	D	D	CON: Protective measures such as the use of silt fences can minimize the impacts
Ecosystem	D	B-	D	D	B-	D	CON: Protective measures such as the use of silt fences can minimized the impacts
Topography & Geological Features	D	B-	D	D	B-	D	CON: Although impacts on topography are not expected, the temporary impacts on the geology can be minimized by protective measures such as silt fences.
Land Use and Utilization of Local Resources	D	B-	D	D	B-	D	CON: Sensitize the community that the new rainwater reservoir can contribute to develop the economic and social conditions of the area to especially improve water supply conditions during emergencies such as droughts.
Existing Social Infrastructures & Services	D	B-	D	D	B-	D	CON: Traffic flow disturbance can be minimized by diverting the traffic during construction.
Infectious Diseases such as HIV/AIDS	D	C	C	D	C	C	CON: Although the infection rate is low, the risk of spreading infectious diseases and transmission can be reduced by taking measures such as guidance on health management of workers. . OPE: The risk of infectious diseases by mosquito breeding in the rainwater reservoirs can be reduced by taking measures such as

Item	Rating during Scoping			Rating based on Survey			Reason
	PLA	CON	OPE	PLA	CON	OPE	
							guidance on health management of staff.
Working Conditions	D	D	D	D	D	D	CON/OPE: Workers and staff are protected and assured of a safe working environment by USOSHA regulations
Accidents	D	B-	C	D	B-	D	CON: A traffic management plan, which includes measures against traffic jams and accidents during construction, will be submitted by the Contractor. OPE: Proper safety protections such as fences and handrails will be installed to reduce the risks of accidents.

Notes:
1) Phase of Activity: PLA: During planning & preparation, CON: During construction, OPE: During operation
2) Rating: A+/-: Significant positive/negative impact is expected, B+/-: Positive/negative impact is expected to some extent, C: Extent of impact is unknown (A further examination is needed, and the impact could be clarified as the study progresses), D: No impact is expected
Source: RMIEPA and JICA Survey Team

1-3-1-8 Mitigation Measures and their Cost for Implementation

The impacts to be considered during the construction and operation phase of the Project were examined using the scoping described above, and their mitigation measures are shown in Table 1.3-17.

Table 1.3-17 Mitigation Measures

Impact Item	Mitigation Measure	Responsible Body	Supervising Organization	Cost
Construction Phase				
Air Pollution	▪ Use of vehicles and machines which are properly tuned to avoid exhaust emission ▪ Sprinkling of water on site and on roads near communities to prevent dust and other particulates	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Water Pollution	▪ Use of materials and construction methods which reduce muddy water and contaminants flowing into the ocean and lagoon	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Solid Waste	▪ Ensure proper collection and disposal of construction waste ▪ Instruction to the workers to clean the construction sites	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Noise & Vibration	▪ Use of silencers in vehicles to minimize noise ▪ Avoid movement of vehicles at night	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Bottom Sediments	▪ Use of protective measures such as silt fences to minimize the impacts	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Ecosystem	▪ Properly drive away and remove marine animals	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Topography & Geological Features	▪ Provide protective measures during construction	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Land Use and Utilization of Local Resources	▪ Explanation on benefits of new reservoir to surrounding residents	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Existing Social Infrastructures & Services	▪ Securing an access path around the construction site ▪ Public awareness raising through displaying construction sign boards	Contractor	MWSC	Contractor: Included in construction cost MWSC: Not needed due to site supervision
Infectious Diseases such as HIV/AIDS	▪ Prepare a guidance program on health management of workers.	Contractor	MWSC	Contractor: Included in construction cost MWSC: Not needed due to site supervision

Impact Item	Mitigation Measure	Responsible Body	Supervising Organization	Cost
Accidents	▪ Setting speed limits (to not more than 25 miles/hr) ▪ Restriction of machinery movement on the designated haulage routes ▪ Adequate safety signs to manage traffic at sites	Contractor	MWSC	Contractor: Included in construction MWSC: Not needed due to site supervision
Quarry and Sand Mining	▪ Reconfirmation of existing quarry and sand pits for environmental impacts such as existence of coral	Contractor	MWSC	Contractor: Included in construction MWSC: Not needed due to site supervision
Operation Phase				
Noise & Vibration	▪ Use of low noise and low vibration equipment	MWSC	MWSC	Included in WTP management cost
Infectious Diseases such as HIV/AIDS	▪ Follow the guidance program on health management of staff.	MWSC	MWSC	Included in WTP management cost

Source: RMIEPA and JICA Survey Team

1-3-1-9 Monitoring Plan

The monitoring plan following the mitigation measures listed above is shown in Table 1.3-18. The proposed monitoring form for the project to be used to report the monitoring results from MWSC to JICA is shown in "1-3-3-1 Monitoring Form (Draft)".

Table 1.3-18 Monitoring Plan

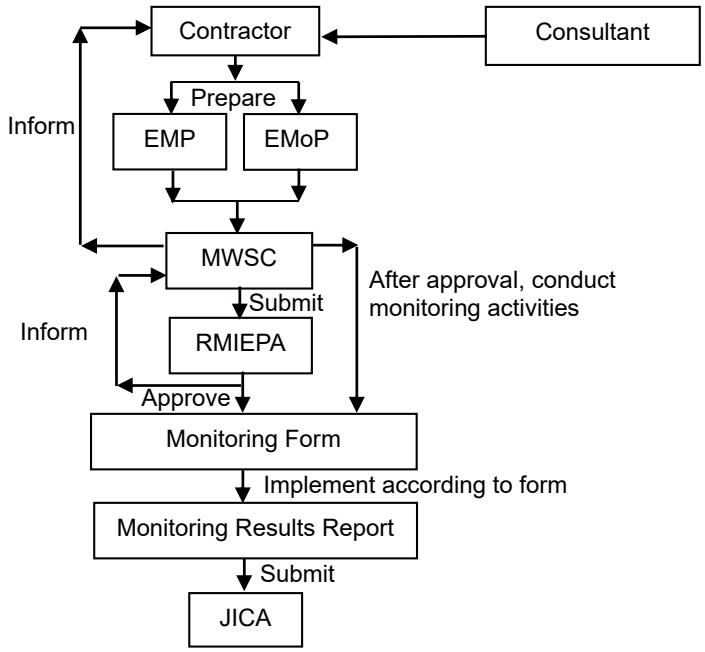
Impact Item	Monitoring Item	Location	Frequency	Responsible Body	Supervising Organization	Cost
Construction Phase						
Air Pollution	• Log of vehicle movement and maintenance • Visual inspection of exhaust gas and dust particles	Around construction site	Weekly	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Water Pollution	• Visual inspection of turbid water in ocean and lagoon • Measurement of pH, EC, COD, oil and Enterococci	Around construction site	Weekly	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Solid Waste	• Visual inspection of proper collection and disposal of construction waste and cleaning of construction site	Around construction site	Weekly	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Noise & Vibration	• Vehicle noise measurement (< 85dB USOSHA)	Around construction site	Weekly	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Bottom Sediments	• Visual inspection of measures to prevent impacts on bottom sediments at the construction site	Around construction site	Weekly	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Ecosystem	• Visual inspection of measures to prevent impacts on the ecosystem at the construction site	Around construction site	Several times daily	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Topography & Geological Features	• Visual inspection of protective measures at the construction site	Around construction site	Monthly	Contractor	RMIEPA	Contractor: Included in construction cost

Impact Item	Monitoring Item	Location	Frequency	Responsible Body	Supervising Organization	Cost
						RMIEPA: Not needed due to site supervision
Land Use and Utilization of Local Resources	• Listening to complaints from the community	Around construction site	Monthly	Contractor	RMIEPA	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Existing Social Infrastructures & Services	• Visual inspection to confirm the availability of access route to detour the construction site, and space to display the construction sign board • Listening to complaints from the community	Around construction site	Once	Contractor	MWSC	Contractor: Included in construction cost MWSC: Not needed due to site supervision
Infectious Diseases such as HIV/AIDS	• Records of sicknesses and diseases • Hearing on health conditions from workers	Construction site	Weekly	Contractor	MWSC	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Accidents	• Records of accidents and near-misses • Visual inspection of site traffic • Listening to complaints from the community	Around construction site	Weekly	Contractor	MWSC	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Quarry and Sand Mining	• Extreme increase of coral around existing quarry and sand pits	Around quarry and sand pit	Before construction	Contractor	MWSC	Contractor: Included in construction cost RMIEPA: Not needed due to site supervision
Operation Phase						
Noise & Vibration	• Noise measurement of pump and other equipment (< 85 dB USOSHA)	WTP	Weekly	MWSC	MWSC	Included in WTP management cost
Infectious Diseases such as HIV/AIDS	• Records of sicknesses and diseases • Hearing on health conditions from staff	WTP	Weekly	MWSC	MWSC	Included in WTP management cost

Source: RMIEPA and JICA Survey Team

1-3-1-10 Organization Structure for Implementation

Based on the mitigation measures and monitoring plan explained above, the contractor will prepare the Environmental Management Plan (hereinafter referred to as “EMP”) and the Environmental Monitoring Plan (hereinafter referred to as “EMoP”). These documents will be submitted to the implementing agency MWSC and MWSC will submit them to RMIEPA for approval. Then, RMIEPA and MWSC will carry out the monitoring activities based on the monitoring form and submit the results to JICA. The organization structure for this procedure is in Figure 1.3-6.



Source: RMIEPA and JICA Survey Team

Figure 1.3-6 Implementation Structure

1-3-1-11 Stakeholders' Meeting

The stakeholders of the Project are the Ministry of Justice, Immigration and Labor (hereinafter referred to as "MJIL"), Ministry of Culture and Internal Affairs (hereinafter referred to as "MCIA") (previous lessee before being transferred to MJIL), Ministry of Finance and Postal Services (hereinafter referred to as "MFPS"), MWIU, Attorney General (hereinafter referred to as "AG") Office, Chief Cabinet Office, Chief Secretary Office, RMI Ports Authority (hereinafter referred to as "RMIPA"), MWSC and land owners.

Meetings of stakeholders related to the Project were held four times. Particulars of the 1st and 4th meetings are outlined below.

The first meeting was held on July 23, 2018 at the Marshall Islands Resort (MIR). At this meeting, the General Manager of MWSC explained the importance of the Project as a countermeasure during droughts, and then the participants agreed on the implementation of this development project. Also, the participants made a request on raising the lease price. A total of 24 members from MCIA, MFPS, MWIU, AG Office, Chief Secretary Office, RMIPA, MWSC and land owners participated in this meeting.

The forth meeting was held on February 2, 2019 at the Women's Training Center. At this meeting, the landowners requested that the lease price be set higher than the current government lease rate stipulated by law, and the government side explained that this will require approval by the Cabinet, and so this will be taken up in the next Cabinet meeting. A total of 34 members from MJIL, AG Office, Chief Cabinet Office, MCIA, RMIPA and land owners participated in this meeting.

Moreover, MWSC plans to hold another meeting to explain the details of the Project, cautions to be taken during construction and expected impacts on the environment and society. The additional meeting will be held well in advance before the construction is scheduled to commence which is July 2021.

1-3-2 Land Acquisition and Resettlement

1-3-2-1 Necessity for Land Acquisition and Resettlement

About 5.7 ac (2.3 ha) of land is required for the construction of the rainwater reservoir of the Project. All the land in RMI belongs to private individuals, but the government can use it under a land lease agreement with the landowner if the land is necessary for public development projects (only if profit is not generated).

In RMI, the traditional land ownership concept is deeply rooted and the proposed project site is land for which the Marshallese government has a long-term lease agreement with the landowners of the adjacent land. In addition, Since there are no alternative sites suitable for the Project, the proposed land has to be acquired for the Project through a legal lease agreement. The rainwater reservoir construction site of the Project spans two Wetos (an administrative unit under a village), Nakan Weto and Katoj Weto, which are located between the east side of Majuro International Airport and the existing rainwater reservoir No.6. As noted earlier, the Marshallese government and the owners have already signed a 25-year lease agreement for the acquisition of this land for the Majuro International Airport and the existing rainwater reservoir, but the lease expires in 2020, and process to renew the lease for another 25 years is underway. The final consensus of the landowners and completion of the lease agreement renewal is a prerequisite for implementation of the Project, and necessary procedures and responsible persons were confirmed by the M/D of the 1st Field Survey. Documents received as evidence on the legal use of the land proposed for the Project, including results of renewal process, are shown in Appendix-5.

Since the project site is located on open land which submerges during high tide, there are no residences and hence resettlement is not necessary.

1-3-2-2 Legal Framework for Land Acquisition and Resettlement

(1) Summary of Legal System for Land Acquisition and Resettlement of Recipient Country

Land acquisition in RMI is defined in Article II, Section 5 of the Constitution (2005) and the Land Acquisition Act 1986. However, regulations on resettlement in RMI do not exist.

According to the Constitution and Land Acquisition Act, whenever land is required, the government can acquire the land only for public use under authority of the law. However, just compensation is to be given to the landowner

If land is needed for development of a public project, the minister of the ministry in charge of the project must obtain evidence of legal use from the Supreme Court through the Attorney General (AG). Also, consultation with the Traditional Rights Court is needed to determine whether the compensation for use is legitimate.

(2) JICA Policy on Resettlement

The policy of JICA regarding resettlement is shown in Table 1.3-19, and they are compared with the relevant RMI laws below.

(3) Comparison between JICA Guidelines and Marshallese Laws on Resettlement

A comparison of JICA Guidelines and Marshallese laws related to land acquisition and resettlement is shown in Table 1.3-19. Since there are no acts or regulations related to resettlement in the Marshall Islands, the Land Acquisition Act is used for the comparison.

Table 1.3-19 Comparison between JICA Guidelines and Marshallese Laws

No.	JICA Guidelines	Marshallese Laws	Gap with JICA Guidelines	Land Acquisition Policy for this Project
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Whenever the taking of land rights forces those who are dispossessed to live in circumstances reasonably requiring a higher level of support, that fact shall be considered in assessing whether the compensation provided is just. (CMI Sec.5(6) and LAA Sec.208(2))	No difference	Marshallese law is applied
2.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Before any decision is made by the Minister to acquire any particular land, the Minister shall be satisfied that there does not exist any alternative means, by landfill or otherwise, of achieving at non-prohibitive expense the purpose to be served by such acquisition. (LAA Sec.205(2))	No difference	Marshallese law is applied

No.	JICA Guidelines	Marshallese Laws	Gap with JICA Guidelines	Land Acquisition Policy for this Project
3.	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	Where any land or servitude is taken, the amount of compensation shall include reasonably equivalent land rights for all interest holders or the means to obtain the subsistence and benefits that such land rights provide. (CMI Sec.5(5) and LAA Sec.208(1))	No difference	Marshallese law is applied
4.	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	In determining whether compensation for land rights is just, the High Court shall refer the matter to the Traditional Rights Court and shall give substantial weight to the opinion of the Traditional Rights Court. (LAA Sec.208(3))	No difference	Marshallese law is applied
5.	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Before any land right or other form of private property is taken, there must be a determination by the High Court that such taking is lawful and an order by the High Court providing for prompt and just compensation (CMI Sec5(4))	No difference	Marshallese law is applied
6.	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	Where the Minister considers that particular land is suitable for a public use, or that a particular servitude over particular land should be acquired for public use, he shall direct the Secretary to cause notice to be given to the owner or owners of that land to be exhibited in some conspicuous places on or near that land; provided, however, that it shall not be necessary to give a notice to the owner or any owner of land whose name and address cannot be found or ascertained. (LAA Sec.205(1))	This Project does not involve resettlement, but in case of land acquisition, a public notice must be issued that the land acquisition is for public use	Not applicable since resettlement is not involved in this Project
7.	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	Same a above	Same as above	Not applicable since resettlement is not involved in this Project
8.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	The notice to be provided by the Minister related to land acquisition shall: (a) be in the Marshallese and English languages; (b) contain a description of the land or servitude which is intended to be acquired; (c) state that the Government of the Marshall Islands intends to acquire that land or servitude for public use, and that written objections to the intended acquisition may be made to the Secretary; and (d) specify a period within which such objections must be made, such period being not less than one month from the date on which such notice is given. (LAA Sec.205(3))	No difference	Marshallese law is applied.
9.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	Where a notice relating to the intended acquisition of land or of a servitude over land is exhibited, and objections to such acquisition are made to the Secretary by any of the persons interested in the land within the time allowed therefore in the notice, the Secretary shall consider such	Recommenda-tions on objections to land acquisition must be made	Not applicable since resettlement is not involved in this Project

No.	JICA Guidelines	Marshallese Laws	Gap with JICA Guidelines	Land Acquisition Policy for this Project
		objections and make recommendations to the Minister. When such objections are considered every objector shall be given an opportunity of being heard in support thereof. After the consideration of the objections the Secretary shall make his recommendations on the objections to the Minister.(LAA Sec.205(4))		
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	Same a above	No difference	Marshallese law is applied
11.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	"Person interested", with reference to land, means an Iroij Laplap, Iroij Erik, Alab and Senior Dri Jerbal, and any or all persons claiming under them, or a person having an interest in the land, as owner, co-owner, mortgagee, lessee or otherwise, whether absolutely for himself or in trust for any other person, or for any charitable, religious or other purpose, or a person having a servitude over land. "Person interested" does not include a monthly tenant. (LAA Sec.202(e))	Definition of land owners	Marshallese law is applied
12.	Eligibility of benefits includes, the Project Affected Persons (hereinafter referred to as "PAPs" who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Same as above.	No difference	Marshallese law is applied
13.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Where land is available for the purpose of exchange with other landowners and any person to whom compensation for the acquisition of any land is payable, the Minister may enter into an agreement with the landowners of such land to transfer a portion of that amount of land in lieu of the land acquired, in the name of the person to whom compensation is payable, for the sum awarded as compensation for the acquisition for such land. (LAA Sec.215(1))	No difference	Not applicable since resettlement is not involved in this project
14.	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	The amount payable to the landowners of such land who have agreed to transfer to such person who is willing to accept such land in lieu of compensation, shall be the amount of compensation which has been assessed for the land acquired. (LAA Sec.215(2))	Compensation amount must be the assessed value	Marshallese law is applied
15.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly,	None	There are no vulnerable groups in the Project area	Not applicable since resettlement is not involved in this Project

No.	JICA Guidelines	Marshallese Laws	Gap with JICA Guidelines	Land Acquisition Policy for this Project
	women and children, ethnic minorities etc. (WB OP4.12 Para.8)			
16.	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	None	Laws on abbreviated resettlement plan do not exist	Not applicable since involuntary resettlement is not involved in this Project

JICA GL: JICA Guidelines; WB OP: World Bank Operational Policy; CMI: Constitution of the Marshall Islands; LAA: Land Acquisition Act
Source: JICA Guidelines, Constitution of the Marshall Islands, Land Acqisition Act and JICA Survey Team

(4) Project Policy on Land Acquisition and Resettlement

The Project policy on land acquisition (resettlement is not involved in this Project) is shown in Table 1.3-20.

Table 1.3-20 Project Policy on Land Acquisition and Resettlement

I. In case resettlement becomes involved, the Government of the Marshall Islands will use the Project Resettlement Policy (the Project Policy) for this Project specifically because the existing national laws and regulations have not been designed to address involuntary resettlements according to international practices, including JICA's policy. The Project Policy is aimed at filling-in any gaps in the local laws and regulations in order to ensure that PAPs are rehabilitated to at least to their pre-project condition. The principles of the Project Policy and the entitlements of the PAPs, which are based on the type and degree of their losses, are discussed as follows.
II. Since the target land is an open space in the reef, which is submerged during high tide, and with no residences, resettlement is not necessary. However, since the current land lease agreement between the land owners and the Marshallese government is about to expire, a 25-year renewal of the lease agreement is necessary.
III. When land has to be acquired and alternative means are not available, agreement with the land owners is necessary.
IV. Compensation for land acquisition must be based on the governmental lease rate in consideration of the livelihood of the affected persons, and paid before commencement of construction.
V. Notice for land acquisition must be provided in the Marshallese and English languages with description of the land, its use for public purposes, and grievance period.
VI. Complaints against land acquisition must be fully addressed.
VII. Land owners are the only persons affected by the land acquisition, and they are limited to the following: (note that a monthly tenant is not included):
- Iroij Laplap, Iroij Erik, Alab and Senior Dri Jerbal, and any or all persons claiming under them
- A person having an interest in the land, as owner, co-owner, mortgagee, lessee or otherwise, whether absolutely for himself or in trust for any other person, or for any charitable, religious or other purpose, or a person having a servitude over land

Cut-off-date of Eligibility

The 25-year lease contract for the target land, which is about to expire, was signed in 1995, and an agreement was reached to renew it for another 25 years starting from 2020; therefore, the cut-off date will be May 31, 2020.

Principle of Replacement Cost

Since replacement cost is not involved in this Project, renewal of the lease fee is applied.

1-3-2-3 Scale and Scope of Land Acquisition and Resettlement

As already noted, the site proposed for the construction of the reservoir is a plot of about 5.7 ac (2.3 ha) spanning two Wetos, Nakan Weto and Katoj Weto. The plot is located between the east side of Majuro International Airport and the existing rainwater reservoir No.6, and it is submerged during high tides of the sea.

(1) Population Census

As explained above, the Project site is a reef, which gets below the surface of the sea during high tides and therefore, with no residences.

(2) Property and Land Survey

Data on physical or economical assets related to the site are not available.

(3) Household and Life Survey

Basic information on standard characteristics and livelihoods of the households to be compensated through the lease is not available.

(4) Vulnerable People

Vulnerable groups do not exist at the Project site.

1-3-2-4 Specific Measures for Compensation and Support

According to the Marshallese Constitution and the Land Acquisition Act, an appropriate compensation must be paid to the landowner if land acquisition is required. The lease rate is limited to USD4,000/ac/year, which is the current government lease rate for undeveloped land.

(1) Loss Compensation

Losses are not involved in this Project.

(2) Rehabilitation

Rehabilitation is not necessary for this Project.

(3) Site Relocation for Resettlement

Since resettlement is not involved, relocation is not necessary in this Project.

(4) Entitlement Matrix

Since losses are not involved in this project, entitlement matrix is not needed.

1-3-2-5 Mechanism for Grievance Adjustment

Any objection to the land acquisition must be submitted within a month after the intended land acquisition is submitted to the High Court to confirm its legality Then the Court will decide whether the acquisition of such land is lawful. If the Court decides that it is lawful, the payment of compensation will be ordered. Also, all complaints will be discussed in public consultations.

1-3-2-6 Implementation Structure

The responsibility of government lease was transferred from the MCIA to MJIL on November 23, 2018. Therefore, MJIL becomes the lessee of the acquired land, and the landowners of the two Wetos in which the Project site is located become the lessor of the land lease contract.

1-3-2-7 Implementation Schedule

As already noted, the original 25-year lease contract, from June 1, 1995, until May 31, 2020, is soon to expire, and the process to renew it for another 25 years is underway. An agreement was reached on the submission of the land ownership documents and this was confirmed in the M/D signed on May 29, 2019.

1-3-2-8 Costs and Financial Sources

The lease rate of the original contract was USD3,000/ac/year, but the rate for the renewal can be negotiated as long as it does not exceed the current government rental rate for undeveloped land of USD4,000/ac/year. The landowners have already demanded a higher rate, but RMI Government explained that this would be discussed in the next Cabinet meeting. Afterward, in order for the landowners to understand a necessity of the land lease for the Project, RMI Government explained outline of the Project and land lease to the landowners on May 11, 2020. Finally, RMI Government and the landowners agreed to the addendum to the master ground lease agreement between Majuro International Airport and Water Distribution System Adjacent Landfill Area on May 20, 2020.

1-3-2-9 Monitoring Procedure Form

A total of four public consultations on land acquisition for the Project were held. As is explained in Table 1.3-21, a final agreement on the lease renewal price is needed. Using the proposed monitoring form shown below, MWSC must monitor the progress and report to JICA.

Table 1.3-21 Draft of Land Acquisition Monitoring Form

Claimant		Affected Land	Affected Land Area (ac)	Lease Price (USD/ac/year)	Status of Payment	Remarks
1	Kelai Nemna	Nakon Weto				
2	Jitenboro Konou	Nakon Weto				
3	Item Andrike	Nakon Weto				
4	Kelai Nemma	Katoj Weto				
5	Rosalie DeBrum	Katoj Weto				
6	Bedrik Filimoni	Katoj Weto				
Total			5.7			

1-3-2-10 Public Consultation

During the four public consultations, particular features of the Project were explained. The summaries of the first and fourth public consultations are provided in Tables 1.3-22 to Table 1.3-24, respectively.

Table 1.3-22 First Public Consultation on Land Acquisition

Item	Contents
Date and Time	July 23, 2018, From 10:35
Venue	MIR Melele Room
Attendants	Minister of MCIA, Minister of MFPS, Minister of MWIU, Attorney General, Deputy AG, Deputy Chief Secretary, Director of RMIPA, Secretary for MCIA, General Manager of MWSC, 15 landowners
Meeting Note	Concerning the contract renewal, the representative of the landowners proposed raising the lease rate from USD4,000/ac/year to USD7,000/ac/year. The Minister of MFPS explained that this is difficult because the operating budget is higher than the revenue. A participant commented that USD7,000/ac/year is not practical for reclaimed plots. The implementation of the development project did not face any objection, and the General Manager of MWSC underlined the importance of the Project as a countermeasure against droughts.

Source: Meeting Notes and JICA Survey Team

Table 1.3-23 Fourth Public Consultation on Land Acquisition

Item	Contents
Date and Time	February 26, 2019, From 14:00
Venue	Women's Training Center
Attendants	Minister of MJIL, Attorney General, Deputy AG, 3 Assistant AGs, 2 from RMIPA, 1 from Chief Secretary' Office, Assistant Secreatry of MCIA, 24 landowners
Meeting Note	Concerning the contract renewal payment, the representative of the landowners requested an increase in lease payment from the current government lease rate of USD4,000/ac/year to USD7,000/ac/year which can be covered by revenue generated from Majuro International Airport operation. The AG explained that any changes in the lease rate would require Cabinet approval. Furthermore, the representative of RMIPA explained that Majuro International Airport does not generate any surplus revenue by showing the revenues and expenditures. Finally, the Minister of MJIL noted that he would bring up the points discussed in the meeting with the Cabinet.

Source: Meeting Notes and JICA Survey Team

Table 1.3-24 Fifth Public Consultation on Land Acquisition

Item	Contents
Date and Time	May 11, 2020

Item	Contents
Venue	MWIU
Attendants	Attorney General, 1 from PMU, MWIU, 1 from RMIPA, General Manager of MWSC, 2 landowners (Katoji Weto and Nakan Weto)
Meeting Note	In order for the landowners to understand a necessity of the land lease for the Project, RMI Government explained outline of the Project and land lease to the landowners.

Source: Meeting Notes and JICA Survey Team

1-3-3 Others

1-3-3-1 Monitoring Form (Draft)

The proposed monitoring form to be used by the implementing agency to monitor the Project and report the results to JICA during construction and operation is shown below.

(1) During Construction

1) Pollution Control

- Air Pollution

Monitoring Item	Remarks (Measurement point, frequency, method)
Vehicle exhaust gas and construction dust	Around construction site, Weekly, Visual inspection of vehicle movements and maintenance records as well as construction area water spraying

- Water Pollution

Monitoring Item	Remarks (Measurement point, frequency, method)
Turbidity in ocean and lagoon	Around construction site, Weekly, Visual inspection (confirm turbidity of waters)

Item (Unit)	Measured Value (Mean)	Measured Value (Maximum)	EPA Standard	EHS[3] Standard	Japanese Standard	Remarks (Measurement point, frequency, method)
pH			6-9	6-9	5-9	Coastal area around construction site, Weekly, water quality analysis
EC (μS/cm)			1,000	-	-	Coastal area around construction site, Weekly, water quality analysis
COD (mg/ℓ)			40	125	2	Coastal area around construction site, Weekly, water quality analysis
Oil (mg/ℓ)			-	10	No oil film	Coastal area around construction site, Weekly, water quality analysis
Enterococci (MPN/100mℓ)			104	-	-	Coastal area around construction site, Weekly, water quality analysis

- Solid Waste

Monitoring Item	Remarks (Measurement point, frequency, method)
Proper collection and disposal of construction waste, and cleaning of construction site	Construction site, Weekly, Visual inspection (confirm collection and disposal of construction waste and cleaning of construction area)

- Noise and Vibration

Item (Unit)	Measured Value (Mean)	Measured Value (Maximum)	RMI Standard	USOSHA Standard	EHS Standard	Remarks (Measurement point, frequency, method)
Noise Level (dB)			None	<85	<70	Around construction site, Weekly, Noise level meter

[3] Environmental, Health and Safety (EHS) Guidelines, Wastewater and Ambient Water Quality, IFC/WB

- Bottom Sediments

Monitoring Item	Remarks (Measurement point, frequency, method)
Temporary impacts on bottom sediments at construction site	Around construction site, Weekly Visual inspection (confirm impacts on bottom sediments)

2) Natural Environment

- Ecosystems

Monitoring Item	Remarks (Measurement point, frequency, method)
Temporary impacts on ecology at construction site	Around construction site, Several times daily, Visual inspection (confirm impacts on fauna and flora)

3) Social Environment

- Existing Social Infrastructures and Social Services

Monitoring Item	Remarks (Measurement point, frequency, method)
Securing access route around construction site, and complaints from community	Around construction site, Once, Survey around site (confirm access and hold hearings)

- Infectious Diseases such as HIV/AIDS

Monitoring Item	Remarks (Measurement point, frequency, method)
Health conditions of workers	Construction site, Weekly, Health records and hearing from workers

- Accidents

Monitoring Item	Remarks (Measurement point, frequency, method)
Accidents during construction, and complaints from community	Around construction site, Weekly, Accident records and survey around site (hearings)

- Quarry and Sand Mining

Monitoring Item	Remarks (Measurement point, frequency, method)
Change in environment around quarry and sand pit such as existence of coral Complaints from community	Around quarry and sand pit, Before and during construction, Visual inspection (confirm impact on environment) and hearings

(2) During Operation

1) Pollution Control

- Noise and Vibration

Item (Unit)	Measured Value (Mean)	Measured Value (Maximum)	RMI Standard	USOSHA Standard	EHF Standard	Remarks (Measurement point, frequency, method)
Noise Level (dB)			None	<85	<70	Around WTP, Weekly, Noise level meter

2) Social Environment

- Infectious Diseases such as HIV/AIDS

Monitoring Item	Remarks (Measurement point, frequency, method)
Health conditions of staff	WTP, Weekly, Health records and hearings from staff

1-3-3-2 Environmental Checklist

The environmental checklist for this water supply project is shown in Table 1.3-25.

Table 1.3-25 Environmental Checklist for Water Supply

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	(a) Have EIA reports been already prepared in official process?	(a) N (b) N	(a) The General Manager of RMIEPA has decided that an EIA is not

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	Permits	(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?	(c) N (d) N	required for this project. (b) As above mentioned. (c) As above mentioned. (d) MWSC has submitted the Earthmoving Permit Application and RMIEPA has issued the permit
	(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) Y (b) Y	(a) Stakeholders meetings were held 4 times and the participants agreed to the construction of the water reservoir. (b) Comments have been reflected.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Alternative options including the zero option were considered comprehensively including environmental and social impacts and results are reported.
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) N (b) Y	(a) Chlorine storage facility is located near the rainwater reservoirs where there are no residences within a 0.311 mi (500m) radius. (b) RMI does not have occupational health and safety standards for chlorine, but USOSHA regulations are applied.
	(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) Y	(a) RMI does not have effluent standards, but since the water source is rainwater, water quality of plant effluent is expected to be in conformity with effluent standards of neighboring countries such as SPREP (Secretariat of the Pacific Regional Environment Programme), Cook Islands and Fiji.
	(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) Y	(a) WTP-C does not generate sludge, but the effluent is slightly turbid as confirmed by MWSC.
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a) Y	(a) RMI does not have regulations on noise and vibration, but applies the USOSHA standard of <85 dB, but there are no residences within a 0.284 mi (457 m) radius.
	(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) N	(a) Rainwater is used as the water source and groundwater is not extracted.
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) N (b) N	(a) There are no protected areas in and around the project site.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests ecologically	(a) N (b) N	(a) The geology of Majuro is coral derived limestone, but there is no

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		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?	(c) N (d) N	coral coverage in the project area (b) The coastal characteristics of Majuro Atoll are almost homogeneous and special biological habitats are not found in the project site. Although a few endemic and endangered species may exist, the project site is not registered as a protected area. If any species appear at the construction site, they will be driven away or removed to a safe area. (c) Ecological impacts are minimal. (d) Water source is rainwater, groundwater is not extracted and there are no surface water sources.
	(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) N	(a) Water source is rainwater.
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? 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) N (b)n/a (c)n/a (d)n/a (e)n/a (f)n/a (g)n/a (h)n/a (i)n/a (j)n/a	(a) Involuntary resettlement is not involved in the project area. (b) Not applicable (c) Not applicable (d) Not applicable (e) Not applicable (f) Not applicable (g) Not applicable (h) Not applicable (i) Not applicable (j) Not applicable
	(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) N (b) N	(a) Construction of the rainwater reservoir will reduce the impact of reduced water supply during droughts to improve the living conditions and livelihood. (b) Since rainwater is used, there is no impact on existing water use.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(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) N	(a) There are no archaeological, historical, and cultural or heritage sites around the project area.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) Y	(a) The tidal flat landscape will change to a reservoir landscape, but the rainwater reservoir is located 0.236 mi (384 m) away from Majuro International Airport and its terminal is a one-story building with a viewpoint about 5 ft (1.5 m) above ground. Therefore, it is difficult to see the embankment forming the boundary between the rainwater reservoir and the sea, and to distinguish between the water surface of the rainwater reservoir and the sea. The nearest residence is about 1 mi (1,609 m) away.
	(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) N (b) N	(a) There are no ethnic minorities or indigenous people around the project site. (b) There are no ethnic minorities or indigenous people around 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 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) Y (b) Y (c) Y (d) Y	(a) MWSC will request the Contractor to take necessary measures such as holding morning assembly and training sessions to secure the safety of workers, individuals involved and local residents. (b) As above mentioned. (c) As above mentioned. (d) As above mentioned.
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) Y (b) Y (c) Y (d) Y	(a) Based on the mitigation measures prepared by RMIEPA and JICA Survey Team, an EMP will be prepared according to the contract between MWSC and the contractor. (b) As above mentioned. (c) As above mentioned. (d) As above mentioned.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(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) Y (b) Y (c) Y (d) Y	(a) Based on the monitoring plan prepared by RMIEPA and JICA Survey Team, the contractor will prepare an EMoP and MWSC will supervise the monitoring activities in accordance with the EMoP. (b) The EMoP will be prepared in accordance with the JICA Guidelines. (c) To ensure proper implementation of the EMoP, MWSC will supervise the contractor before and during the construction. (d) Those are stipulated in EMP.
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)n/a	(a) Not applicable
	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) N	(a) Impacts on transboundary or global issues are not expected.

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.

1-4 Development Partners

1-4-1 Coordination of Project with Development Partners

Division of International Development Assistance (hereinafter referred to as "DIDA") is coordinating to avoid duplication of projects regarding support projects by development partners. Development partners focus on energy, environment, and water and sanitation support by World Bank and Asian Development Bank (hereinafter referred to as "ADB"). A list of development projects (including the planning stage) supported by development partners in the Marshall country is shown in Table 1.4-1. In the light of renewable energy promotion in RMI, the project of solar power generation system installation to be assisted by World Bank is highlighted in light gray in Table 1.4-1. This project is to develop a float type solar power generation system on surface of the five existing rainwater reservoirs. In addition, in case that introduction of a solar power generation system on the surface of the new rainwater reservoir to be constructed in the Project is not included in the Project, MEC as well as World Bank will examine future introduction of a solar power generation system, because a surface of rainwater reservoir is a promising place for solar power generation. Other supports by World Bank include an environmental support centering on the conservation of marine resources.

ADB is supporting the expansion of the airport runway water catchment facilities, the renewal of drainage pipes and sewer pipes, and measures to reduce non-revenue water (hereinafter referred to as "NRW") through the "Majuro Water and Sanitation Project". The cost required for the "Majuro Water and Sanitation Project" is approximately USD25 million, of which ADB contributes approximately USD6 million. For shortfalls, ADB expects contributions from Australia (about USD4 million) and World Bank (about USD15 million).

Table 1.4-1 Status of Energy, Environment, Water, Sanitation Project by Development Partners

Development Partner	Project and or Program	Marshall Agency	Implementation Period (year)	Budget (USD)
World Bank	Pacific Regional Ocean scape Program	MIMRA	2015-2020	8.58 million
World Bank	RMI Pacific Resilience Program Phase 1 (PREP Phase 1) - Catastrophic Risk Insurance	MOF	2015-2018	1.5 million
World Bank	RMI Pacific Resilience Program Phase 2 (PREP Phase 2)	MOF and MWIU	2017-2022	● National IDA: 19.6 million ● Regional IDA: 4 million ● GCF: 25 million ● PPA: 500,000
World Bank	RMI Sustainable Energy Development Project (SEDeP)	MEC	2018-2022	● 34 million ● PPA: 600,000
World Bank	Marshall Islands Maritime Investment Project	RMIPA MoTC	From 2019 Period: N.A.	● 33.12 million
EU EDF 11th	Renewable Energy and Energy Efficiency Project	MOF, Energy Planning Division (hereinafter referred to as "EPD")	2017-2022	9.1 million EURO in total ● Renewable Energy and Energy Efficiency: 8 million EURO ● Support measures to NAO: 700,000 EURO ● Support measures to civil society: 400, 000 EURO
EU-GIZ ACSE	Long-term solution to improve water supply resilience for the outer islands high school	MOF	Completed 2017-2018	125,000 EURO
GIZ	Low Carbon Sea Transport Project	MoTC	2017-2022	9.5 million EURO
ADB	TA8581- Public Sector Management Kwajalein Atoll Local Government Public Financial Management Capacity Improvement Project	Kwajalein Atoll Local Government (KALGov)	Completed in 2017 Period: N.A.	69,423
ADB	Public Sector Management Improvement Project	MOF	2017-2020	2 million
ADB	Improving the Quality of Basic Education in the North Pacific Project	Public School System (PSS)	2017-2024	8 million (5-6 million from RMI allocation, 2 million from co-financing: regional project)
ADB	Majuro Water and Sanitation Project	To be determined	In identification Period: N.A.	15 million
ADB	Ebeye Water Supply and Sanitation Project	Kwajalein Atoll Joint Utilities	2016-2021	19.020 million (ADB: 5 million),

Development Partner	Project and or Program	Marshall Agency	Implementation Period (year)	Budget (USD)
		Resources Inc. (hereinafter referred to as "KAJUR")		(Australia: 4 million, (Compact Grant: 10.02 million)
ADB	Renewable Energy Project-MEC fuel tank farm refurbishment	MEC, EPD	In identification Period: N.A.	5-6 million
ADB	Technical Assistance-investment plan, master planning, tariff review and analysis	MEC	Completed in 2017 Period: N.A.	750,000
ADB	Majuro Power Network Strengthening Project	MEC	Completed in 2017 Period: N.A.	2 million
ADB	GCF Pacific Renewable Energy Investment Program	MEC	Period: N.A.	Not confirmed yet
New Zealand	RMI Renewable Energy Project	MEC, KAJUR, EPD	2017-2019	1 million
Abu Dabi Fund for Development (ADFD)	RMI Renewable/Hybrid Micro-grid project	National Energy office (NEO)	Approved Period: N.A.	11 million (Loan)
International Cooperation and Development Fund (ICDF) (Taiwan)	Loan for purchasing home solar units for residents of Majuro and Ebeye		In implementation Period: N.A.	4 million (Loan)

Source: JICA Survey Team prepared based on documents that DIDA provided

1-4-2 Possibility of introducing Solar Power Generation System in the Project Site

According to the Marshall Islands Electricity Roadmap announced in December 2018, RMI has considered renewable energy such as solar power generation energy instead of fossil fuel energy. RMI has plans to replace current electricity with 100% renewable energy in the future. MEC is implementing the "Sustainable Energy Development Project (SEDeP)" Project ID: P160910 ("SEDeP") to realize the Roadmap. This project is the first investment plan for the Roadmap. This is a solar power generation system introduction project based on a float type solar power generation system using the water surface of the five existing rainwater reservoirs.

Water surface of the rainwater reservoir is effective for installing photovoltaic power generation system. When installing a photovoltaic power generation system, it is necessary to procure equipment for supplying stable electricity with minimal fluctuations to customers, which is expected to require a large amount of project cost. For this reason, the photovoltaic power generation system using the water surface of the rainwater reservoir is not included in the Project, and it is described in M/D (9-2) of the 1st Field Survey.

CHAPTER 2 CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concepts of the Project

In order to achieve the above overall goal and project purpose, rainwater reservoir and rainwater transmission pipelines will be developed, and revetment will be constructed to prevent erosion and adverse effects of salinity on the rainwater reservoir.

The development of the additional rainwater reservoir is expected to increase the raw water storage capacity.

Basic concept of the Project is summarized in Table 2.1-1.

Table 2.1-1 Project Design Matrix (PDM)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	External Condition
Overall Goal: ● To ensure potable and domestic water at Majuro Atoll in the future under all conditions, even during drought	● Increase in the number of water supply days during draught	● Operation record of the rainwater reservoirs	● Policy on water supply development in RMI is not changed.
Project Purpose: ● To increase storage capacity required for the WTP-C through the construction of a rainwater reservoir	● Increase of the capacity of rainwater reservoir	● Data of measurements	● Operation and maintenance of the rainwater reservoir to be constructed is sustained.
Outputs: ● Increase of storage capacity	● Increase of the capacity of the rainwater reservoirs from 36 MG (138,000 m^3) to 51 MG (195,000 m^3).	● Data of measurements	
Activities: ● Construction of revetment ● Construction of rainwater reservoir ● Development of rainwater transmission pipelines	Inputs: <u>Japan</u> ● Financial assistance required for facility construction ● Consultant ● Contractor <u>Marshall</u> ● Undertakings (land acquisition and arrangement of tax exemption) ● Operation and maintenance ● Assignment of counterparts		Budget required for operation and maintenance is secured. Pre-condition: ● Budgetary arrangement by RMI side is completed. ● Land acquisition is completed with no pending issues. ● All procedures necessary for Environmental Impact Assessment (hereinafter referred to as "EIA"), etc. are completed.

Source: JICA Survey Team

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

This primary aim of the Project is to augment the water storage capacity to improve the water supply during drought. Therefore, the Project will construct a new rainwater reservoir in order to achieve as many water supply days as possible.

The storage capacity increase will be set considering the optimum use of the site required for the

proposed rainwater reservoir.

In addition, the design crest level of the revetment will be set considering extra height to be added to the design wave height, to ensure that the seawater pushed by wind waves does not affect the water stored in the proposed rainwater reservoir. The quarry site for rock required for revetment construction should be selected from in inland areas, because there are corals at reef edges and/or in more offshore areas. When digging for rocks at the quarry site, corals must be protected by using a silt fence, etc.

RMI and Japanese side agreed on the Project components shown in Table 2.2-1 based on the result of a site survey and technical meeting.

Table 2.2-1 Original Project Components and Revised Ones

Items		Original Project Components	Revised Project Components
Facility	Construction of a rainwater reservoir for Treatment Plant C	Construction of rainwater reservoir with storage capacity of about 16 MG (60,567 m^3) and revetment to prevent erosion and adverse effects of salinity on the rainwater reservoir	Construction of rainwater reservoir with storage capacity of about 15 MG (56,900 m^3) and revetment to prevent erosion and adverse effects of salinity on the rainwater reservoir
	Rehabilitation of the existing rainwater reservoirs	Rehabilitation of the existing six rainwater reservoirs	This is not included, because World Bank will plan rehabilitation of all the rainwater reservoirs.
Equip ment	Development of water supply system	Installation of a rainwater transmission pump between the rainwater collection facilities and the proposed rainwater reservoir	This is not included, because MWSC already purchased a rainwater transmission pump.
	Installation of a solar power generation system	Installation of a solar power generation system on the proposed rainwater reservoir	This is not included, because cost of a solar power generation system exceeds the estimated budget of the Project.
	Operation and maintenance	Procurement of a conductivity detector for alarming intrusion of sea water, and a high pressure cleaner for flushing out sludge/ sand in the rain catchment basin and conduit	This is not included, because COMPACT already procured a conductivity detector and a high pressure cleaner for MWSC.

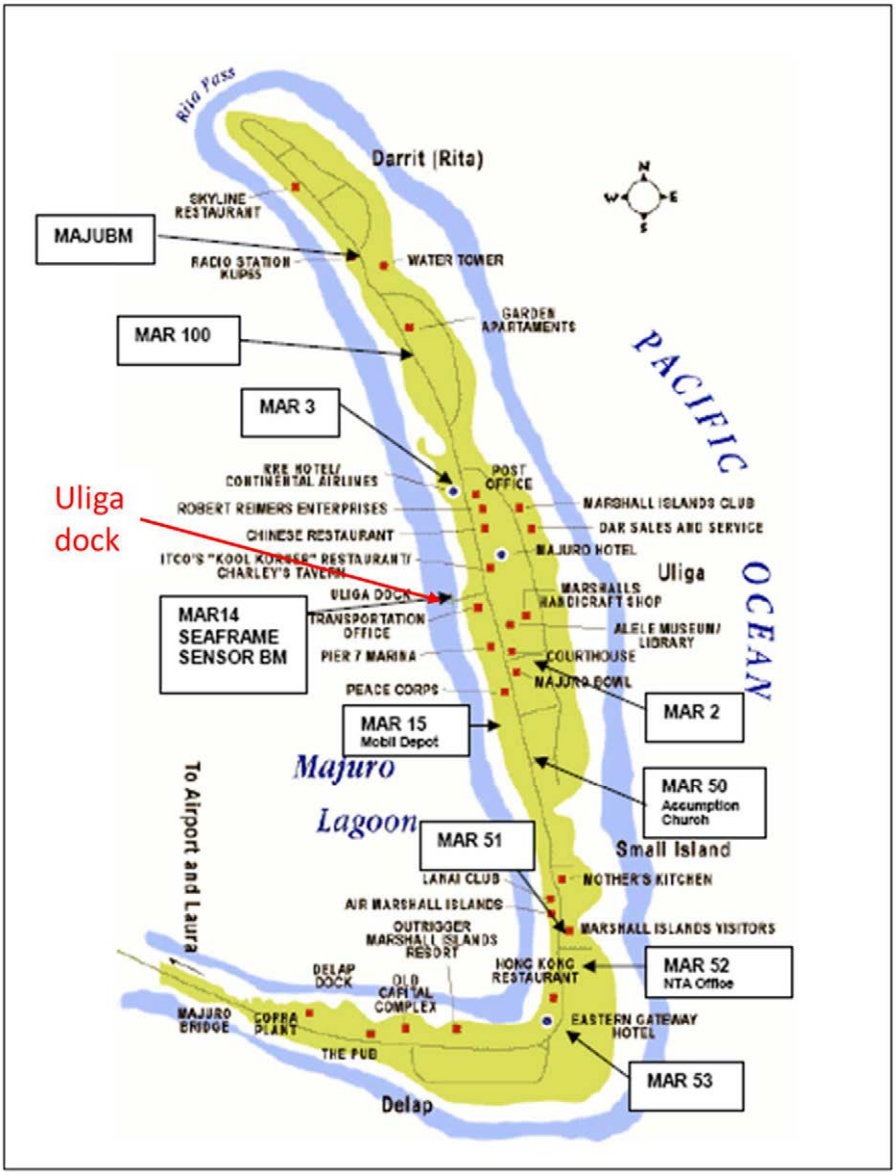
Source: JICA Survey Team prepared based on the request from MWSC.

2-2-1-2 Policies for Natural Conditions

(1) Benchmarks

The benchmarks in Majuro are shown in Figure 2.2-1. The elevation of MAR3 was established in a survey conducted in 1993. The elevations of all the other benchmarks shown in Figure 2.2-1 were determined based on the elevation of MAR3.

MAR3＝MSL(93-94)＋5.2769 ft (1.6083385 m)

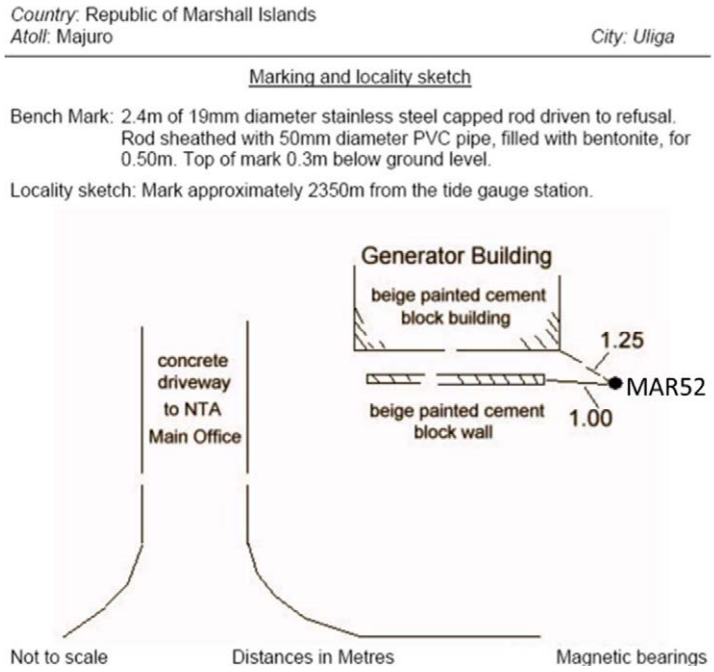


Source: South Pacific Sea Level and Climate Monitoring Project (Australia Government, 2007)

Figure 2.2-1 Existing Benchmarks in Majuro

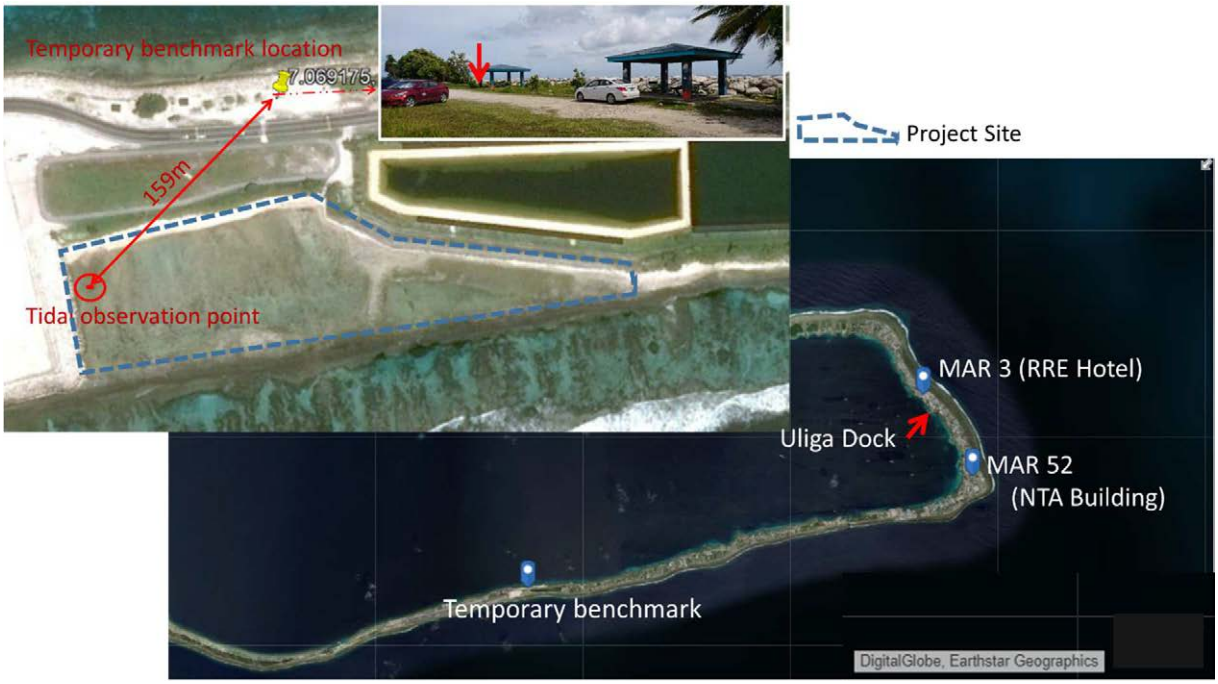
A temporary benchmark for the Project is established by using MAR52. MAR52, which is located approximately 0.656 ft (20 cm) below ground surface, is the nearest benchmark to the Project site, and it is suitable for further maintenance works (see Figure 2.2-2). In addition, since the temporary benchmark will also be used during the construction period, it was established near the southwest corner of the concrete building located on the north side of the Project site (see Figure 2.2-3). Based on the relationship between MAR3 and MAR52 (See Figure 2.2-4), the elevation of MAR52 is calculated as follows:

MAR52＝MAR3 - (8.6 - 8.329) = + 4.370 ft (+1.332 m)



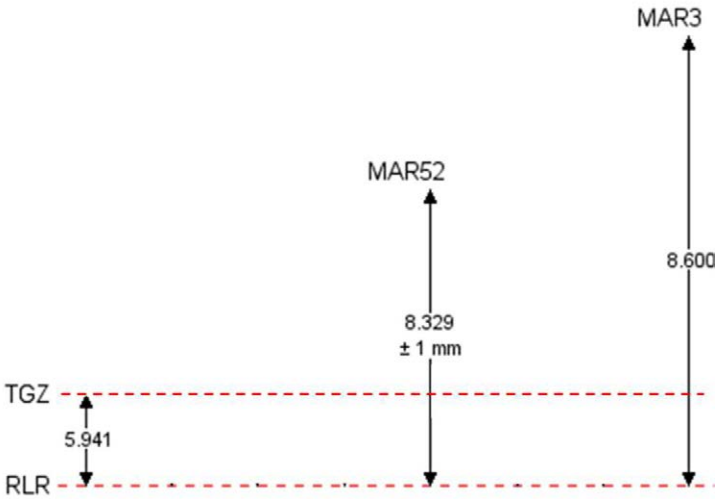
Source: South Pacific Sea Level and Climate Monitoring Project (Australia Government, 2007)

Figure 2.2-2 Location and Detail Information of Benchmark MAR52



Source: JICA Survey Team

Figure 2.2-3 Locations of Tide Observation Point and Relevant Benchmarks



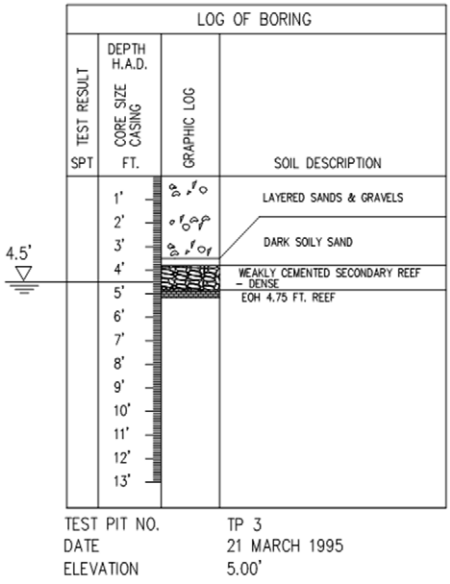
TGZ: Tide Gauge Zero, RLR: Revised Local Reference
Source: South Pacific Sea Level and Climate Monitoring Project (Australia Government, 2007)

Figure 2.2-4 Relationship between MAR3 and MAR5

(2) Soil Condition

The Survey Team collected the nearest existing soil investigation data from MWSC as shown in Figure 2.2-5 (TP-3). The investigation was not conducted by a standard penetration test (hereinafter referred to as "SPT") because it was not based on boring but on test pit. The data show that the first 7 ft (2 m) layer consists of sand, gravel and coral fragments. The second layer reaches the coral rock at (hereinafter referred to as "EL"). 0.25 ft (0.08 m).

The foundation ground of the proposed rainwater reservoir is located on an exposed coral reef at EL. 0 ft (0 m), which corresponds to the elevation of TP-3. The foundation ground is stable as Figure 2.2-6 shows. However, other existing soil investigations in Majuro such as "Supplementary report for basic design study on the Project for Marshall Islands high school up-grading/ development in the Republic of the Marshall Islands (1994.7)" and "Basic design study report on the Project for construction of fish market center at Majuro Atoll in Republic of the Marshall Islands (2019.2)", show alternate layers of sand and reef. Therefore, the soil investigation was conducted in this Survey to confirm the actual soil condition.



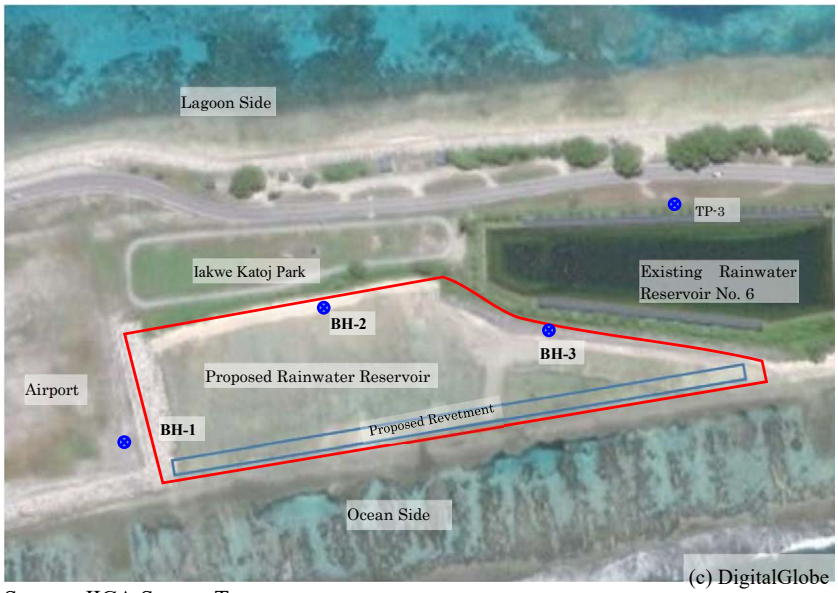
Source: MWSC

Figure 2.2-5 Result of the Existing Soil Investigation (TP 3)

Notes: [Left] View of Existing Rainwater Reservoir No. 6 from Southern Side of Reef through Proposed Rainwater Reservoir, [Right] View of Proposed Rainwater Reservoir from Eastern Side of Reef
Source: JICA Survey Team

Figure 2.2-6 Condition of Foundation Ground of Proposed Rainwater Reservoir

The soil investigation was implemented at BH-1, BH-2 and BH-3 of the site proposed for the rainwater reservoir (Figure 2.2-7). The depth of each borehole is around 65.62 ft (20 m). Soil characteristics of the site are configured in accordance with the results of these surveys as shown in Table 2.2-2. The results of soil investigation shows that the gravelly sand and/or rock fragments are stable, and will not cause consolidation settlement as the foundation ground of the proposed rainwater reservoir.



Source: JICA Survey Team

Figure 2.2-7 Locations of Soil Investigation

Table 2.2-2 Soil Characteristics

Items	Proposed Rainwater Reservoir		
	BH-1	BH-2	BH-3
Soil Characteristics	・1–8 m (3.3–26.2 ft): Gravelly sand ・8–12 m (26.2-39.4 ft): Sandy gravel ・12–20 m (39.4-65.6 ft): Gravelly sand ・20-21m (65.6-68.9 ft): Gravelly sand & rock fragments ・21-23m (68.9-75.5 ft): Gravelly sand	・1–23.25m (3.3–76.3 ft): Gravelly sand	・1–7m (3.3–23.0 ft): Gravelly sand ・7–18m (23.0-59.1 ft): Sandy gravel ・18–23.45m (59.1–76.9 ft): Gravelly sand
N-Value	・1-2m (3.3-6.6 ft): 50	・1-2m (3.3-6.6 ft): 11	・1-2m (3.3-6.6 ft): 28

Items	Proposed Rainwater Reservoir		
	BH-1	BH-2	BH-3
	・2-3m (6.6-9.8 ft): 25 ・3-4m (9.8-13.1 ft): 36 ・4-5m (13.1-16.4 ft): 26 ・5-6m (16.4-19.7 ft): 14 ・6-7m (19.7-23.0 ft): 30 ・8-9m (26.2-29.5 ft): 14 ・9-10m (29.5-32.8 ft): 16 ・10-11m (32.8-36.1 ft): 13 ・11-12m (36.1-39.4 ft): 23 ・12-13m (39.4-42.7 ft): 15 ・13-14m (42.7-45.9 ft): 20 ・14-15m (45.9-49.2 ft): 14 ・15-16m (49.2-52.5 ft): 20 ・16-17m (52.5-55.8 ft): 22 ・17-18m (55.8-59.1 ft): 14 ・18-19m (59.1-62.3 ft): 34 ・19-20m (62.3-65.6 ft): >50 ・20-21m (65.6-68.9 ft): 50 ・21-22m (68.9-72.2 ft): 34 ・22-23m (72.2-75.5 ft): 25	・2-3m (6.6-9.8 ft): 50 ・3-4m (9.8-13.1 ft): 16 ・4-5m (13.1-16.4 ft): 17 ・5-6m (16.4-19.7 ft): 19 ・6-7m (19.7-23.0 ft): 17 ・7-8m (23.0-26.2 ft): 15 ・8-9m (26.2-29.5 ft): 16 ・10-11m (32.8-36.1 ft): 45 ・11-12m (36.1-39.4 ft): 10 ・12-13m (39.4-42.7 ft): >50 ・13-14m (42.7-45.9 ft): 11 ・14-15m (45.9-49.2 ft): 15 ・16-17m (52.5-55.8 ft): 14 ・17-18m (55.8-59.1 ft): 20 ・18-19m (59.1-62.3 ft): 12 ・19-20m (62.3-65.6 ft): 11 ・20-21m (65.6-68.9 ft): 32 ・21-22m (68.9-72.2 ft): >50 ・22-23m (72.2-75.5 ft): 50 ・23-23.25m (75.5-76.3 ft): 50	・4-5m (13.1-16.4 ft): 12 ・5-6m (16.4-19.7 ft): 18 ・6-7m (19.7-23.0 ft): 20 ・7-8m (23.0-26.2 ft): 19 ・8-9m (26.2-29.5 ft): 13 ・9-10m (29.5-32.8 ft): 45 ・10-11m (32.8-36.1 ft): 11 ・11-12m (36.1-39.4 ft): 10 ・12-13m (39.4-42.7 ft): 14 ・13-14m (42.7-45.9 ft): 10 ・14-15m (45.9-49.2 ft): 15 ・15-16m (49.2-52.5 ft): 12 ・16-17m (52.5-55.8 ft): 10 ・17-18m (55.8-59.1 ft): 10 ・18-19m (59.1-62.3 ft): 19 ・19-20m (62.3-65.6 ft): 42 ・20-21m (65.6-68.9 ft): 50 ・21-22m (68.9-72.2 ft): >50 ・22-23m (72.2-75.5 ft): >50 ・23-23.45m (75.5-76.9 ft): 17

Source: JICA Survey Team

Note: The unit of depths as "m" is exchanged into "ft" because the raw data of the survey result is "m".

(3) Quality of Raw Water collected at Majuro International Airport

The rainwater collected at the runway of Majuro International Airport is used as raw water of the water supply. In order to check the existence of oil in rainwater, a sample of the water was taken for analysis. The water quality analysis showed oil content of less than 5 mg/L (below measurable limits).

Moreover, MWSC confirmed that it can close all valves easily to avoid oil inflow into the pump station No. 4 upon an aircraft accident. Therefore, since MWSC has ideas to take emergent actions, introduction of oil elimination measures such as oil fence will not be considered in the Project.

(4) Drought and Precipitation

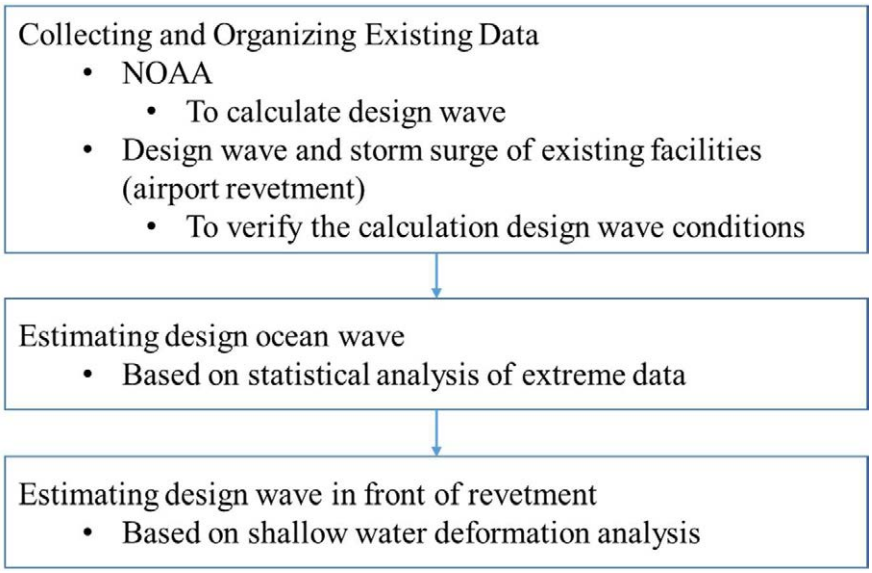
The annual precipitation in Majuro, which was approximately 140 in. (3,556 mm) in the 1950s, has recently decreased to less than 130 in. (3,302 mm). The annual precipitations which were adopted[4] in recent year plans are as follows:

- Average annual precipitation (2011): 144 in. (3,658 mm);
- Dry year precipitation (2009): 109 in. (2,769 mm);
- Extreme drought year precipitation (1983): 86 in. (2,184 mm); and
- Design precipitation for droughts (1998): 102 in. (2,591 mm)

(5) Wave Conditions

Figure 2.2-8 shows the process of wave analysis. The design wave can be estimated utilizing long-term observation data. Since Majuro has not recorded the waves for more than 30 years, design waves were estimated based on limited observation data provided by the United States Department of Commerce - National Oceanic and Atmospheric Administration (hereinafter referred to as "NOAA"), and by considering the design waves of the past projects in Majuro. In detail, the design ocean wave was calculated by extreme wave statistical analysis using NOAA data, and then design waves were estimated based on shallow water deformation analysis. The calculation results were verified using past studies such as design reports of existing facilities.

[4] Beca International Constants Ltd, Capital Improvement Program Support. Consultancy Services Phase 1 - Water Supply Summary Paper, November 2016.



Source: JICA Survey Team

Figure 2.2-8 Wave Analysis Process

1) Collecting and Organizing Existing Data

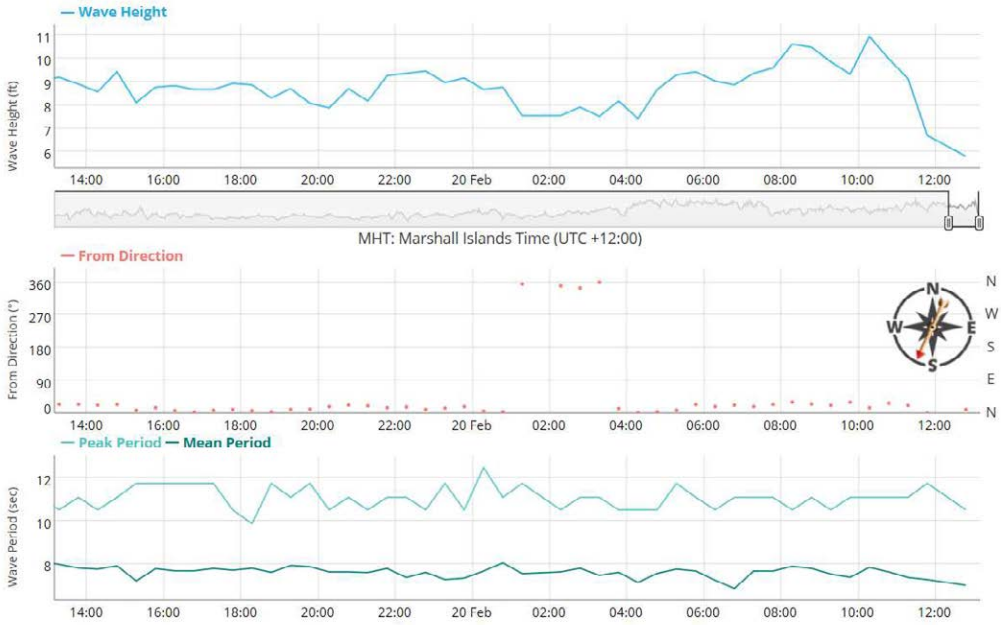
The Project used the wave data collected by a NOAA wave buoy. The NOAA buoy, which is located 295 ft (90 m) offshore of Eastern Majuro (see Figure 2.2-9), collects wave height, wave period, and wave direction every 30 minutes (see Table 2.2-3 and Figure 2.2-10).

Source: JICA Survey Team

Figure 2.2-9 Wave Collection Buoy and Tide Observation Station

Table 2.2-3 Wave Collection Buoy

Station number	CDIP＃163; NDBC＃52201
Location of the buoy	7° 5'0.60"N 171°23'30.60"E (water depth：540 m)
Observation items	Wave height, wave period, wave direction
Unit	Meter (wave height), second (wave period)
Period of observation	From 2010 to 2019
Collection interval	Every 30 minutes
Public data (internet)	Every day from 0:00 to 23:00, at one-hour interval



Source: NOAA

Figure 2.2-10 Sample of Observed Wave Data

2) Design Ocean Wave

The design offshore wave was estimated by extreme wave statistical analysis. The analysis shows that the wave height with a return period of 50 years is 15.091 ft (4.6 m). According to the report titled "The Changing Waves and Coasts in the Pacific" (hereinafter referred to as "WACOP"), the wave height with the same return period in Majuro is 14.010 ft (4.27 m) [5], about 0.984 ft (0.3 m) lower than that of the Project (Table 2.2-4). This difference is observed because the Project estimation is based on the latest data.

Table 2.2-4 Wave Height by Return Period

Large wave height (90th percentile)	2.29 m
Severe wave height (99th percentile)	2.91 m
1 year ARI wave height	3.34 m
10 year ARI wave height	3.93 m
20 year ARI wave height	4.08 m
50 year ARI wave height	4.27 m
100 year ARI wave height	4.40 m

Source：WACOP

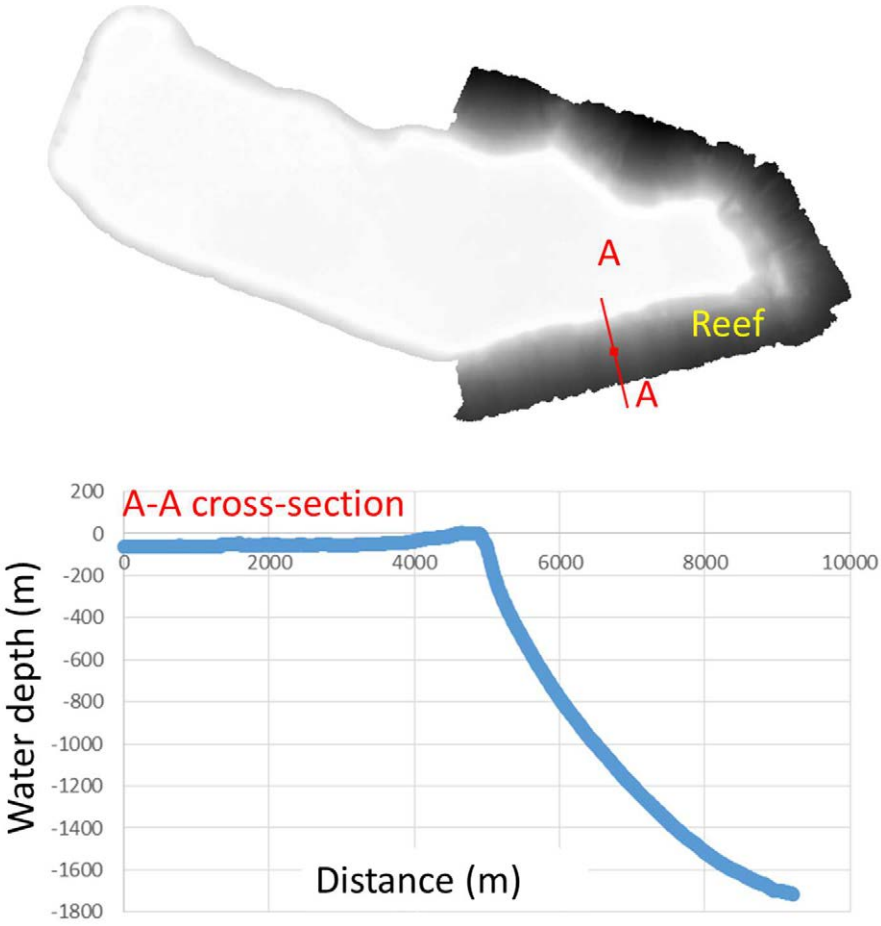
3) Design Wave

The design wave height for the revetment was estimated by conducting a shallow water deformation analysis using the design ocean wave, the cross-sectional data from the topographic survey and the results of the harmonic analysis.

4) Topographic Data

The cross-sectional profile used for shallow water deformation analysis was captured during topographic surveys at the Project site (see Figure 2.2-11). For the portion from the reef edge to the deep sea where surveying is not possible, publicly available Geographic Information System (GIS) data were utilized.

5 Wave Climate Report: Majuro (WACOP, 2014)



Source: U.S. Geological Survey[6]

Figure 2.2-11 Topography of the Project Site

(6) Sea Level Rise

It is necessary to consider the impact of sea level rise due to climate change in the design of revetment. For this purpose, a literature review, including the report on the sea level rise published by the Intergovernmental Panel on Climate Change (hereinafter referred to as "IPCC"), and opinion exchanges with experts were conducted. The results of the review and opinion exchanges will be considered in deciding the future sea level rise, which will be used for the calculation of the crest level of the revetments.

It should be kept in mind that the discussion on the rate of sea level rise included the 32 scenarios provided by the IPCC. Among them, the B1 scenario (the lowest greenhouse gas emissions scenario), the A1B scenario (the medium greenhouse gas emissions scenario), and the A2 scenario (continues increase in greenhouse gas emissions scenario) were extracted and analyzed.

The A2 scenario leads to the highest sea level rise rate followed by the A1B and B1 scenarios, respectively. In the practical design of civil structures, the safety of the structure will be improved if the A2 scenario is assumed. However, the construction cost will increase significantly compared to other scenarios. Therefore, taking into account the balance between safety and construction costs, designs are generally bases on the A1B scenario.

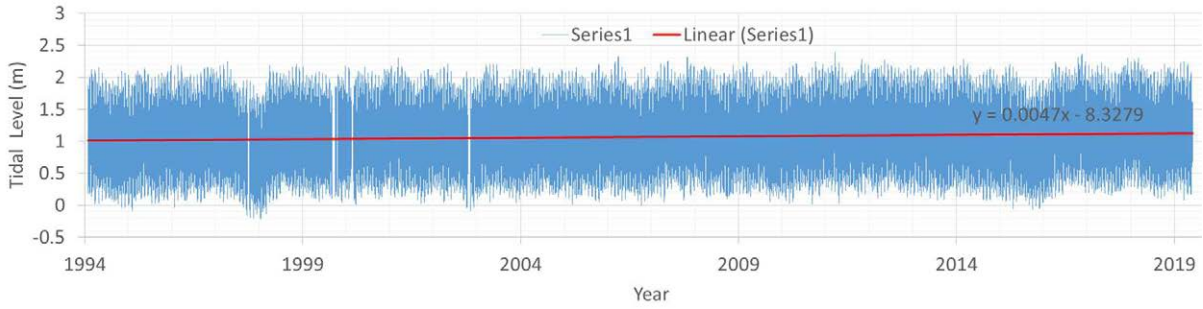
Moreover, Paris Agreement Article 2-1(a) states, *"Holding the increase in the global average temperature to well below 2°C above Pre-industrial levels and pursuing efforts to limit the temperature*

6 Palaseanu-Lovejoy, M., Poppenga, S.K., Danielson, J.J, Tyler, D.J., Gesch, D.B., Kottermair, M., Jalandoni, A., Carlson, E., Thatcher, C., and Barbee, M., 2017, One Meter Topo bathymetric Digital Elevation Model for Majuro Atoll, Republic of the Marshall Islands, 1944 to 2016: U.S. Geological Survey data release

increase to 1.5°C above pre-industrial levels…". In addition, the 48th IPCC General Assembly approved the summary for policymakers and the main content of the IPCC "1.5°C SPECIAL REPORT". In other words, in order to limit the global average temperature rise to 1.5°C instead of 2°C, it is considered appropriate to adopt the A1B scenario.

The sea level rise rate is determined based on 1) analysis of field observation data, 2) IPCC report, and 3) publicly available NOAA data as discussed below.

1) Analysis of field observation data: The field observation data analyzed includes the tidal data observed by the tidal observation station installed by the Australian Bureau of Meteorology in Uliga Dock (Majuro). The result of trend analysis indicates that the sea level is rising at a speed of 4.7 mm/year (see Figure 2.2-12).



Source: JICA Survey Team created based on data from The Bureau of Meteorology- Australian Government

Figure 2.2-12 Change in Tidal Level of Majuro (1994-2019)

2) IPCC report: According to the IPCC report, the average global sea level rise rate in the A1B scenario is estimated to be +3.45 mm/year. It can be seen that the sea level rise rate of 4.7 mm/year obtained from the trend analysis is about 1.4 times the world average. In addition, the IPCC reports show that the sea level rise rate in Western Pacific countries reached about three times the world average from 1993 to 2012 (see Figure 2.2-13) [7].

Since the late 20th century, satellite measurements of the height of the ocean surface relative to the center of the Earth (known as geocentric sea level) show differing rates of geocentric sea level change around the world (see FAQ 13.1, Figure 1). For example, in the western Pacific Ocean, rates were about three times greater than the global mean value of about 3 mm per year from 1993 to 2012. In contrast, those in the eastern Pacific Ocean are lower than the global mean value, with much of the west coast of the Americas experiencing a fall in sea surface height over the same period. *(continued on next page)*

Source: AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability; Chapter 13, p.1148 (IPCC Report)

Source: https://www.iapb.org/iapb-regions/western-pacific/western-pacific-countries/

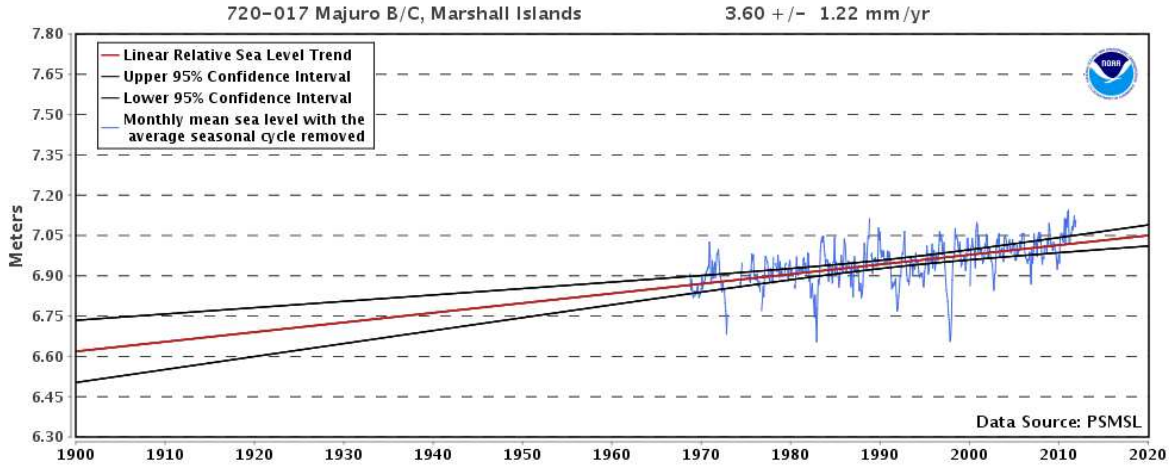
Figure 2.2-13 Western Pacific Countries (dark blue)

7 IPCC AR5 Report, Climate Change 2014: Impacts, Adaptation, and Vulnerability, Chapter 13

3) Publicly available NOAA data: NOAA data indicate that the sea level rise rate at Majuro is 3.6 ± 1.22 mm / year, and similar rates are observed in the surrounding island countries (Apra Bay-Guam: 3.68 ± 3.98 mm / year, Kapingamarangi- Micronesia: 3.40 ± 2.26 mm / year, Funafuri-Tuvalu: 3.74 ± 2.95 mm / year) as shown in Figure 2.2-14 and Figure 2.2-15.

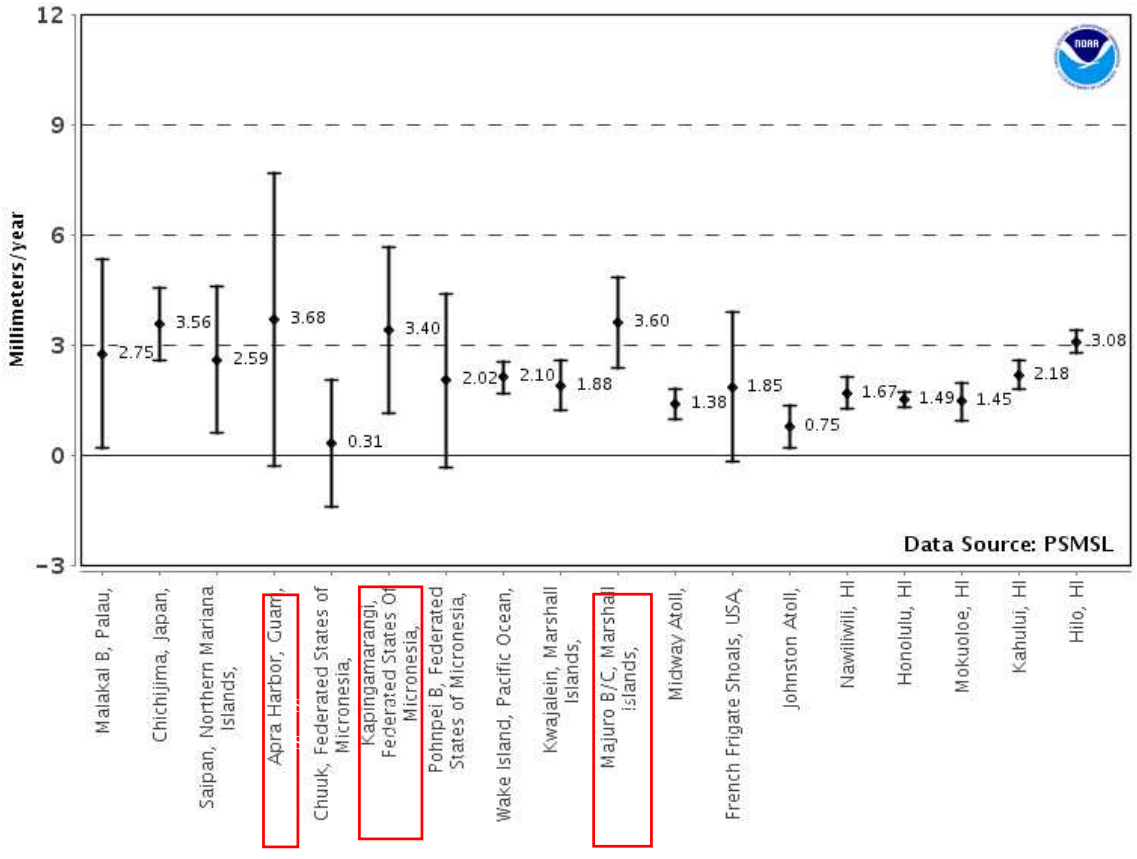
On the other hand, the 2015 revetment rehabilitation project of the East Runway of Majuro International Airport, which is close to the Project site, adopted a sea level rise rate of 4.5 mm/year[8].

Based on the analysis results of field observation data and the sea level rise rates of the NOAA reports, it was judged that the sea level rise rate adopted by the nearby project was appropriate. Therefore, a sea level rise rate of 4.5 mm/year (0.23 m/50 years) was adopted for the Project.

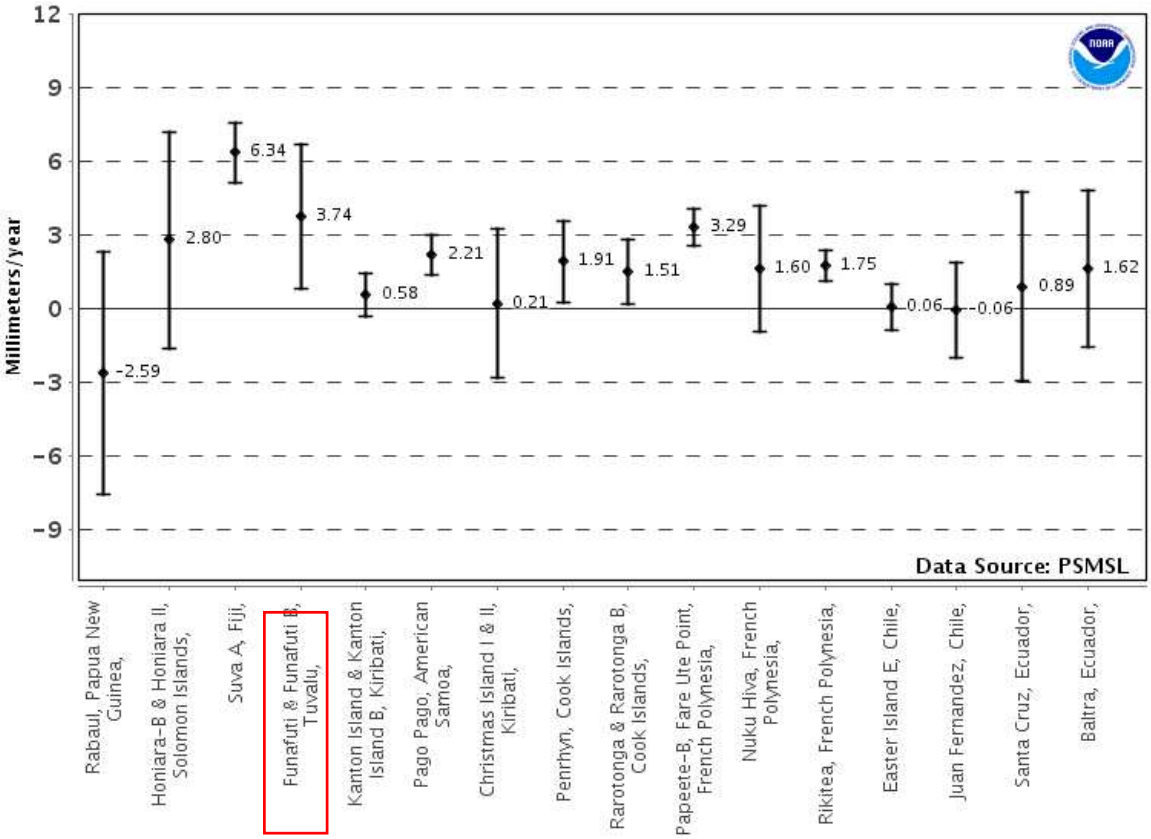


Source: NOAA

Figure 2.2-14 Trend of Sea Level Rise at Majuro by NOAA



8 Majuro Airport Eastern Runway Safety Area Design Report (BECA, 2015)



Source: NOAA

Figure 2.2-15 Trend of Sea-Level Rise in the Pacific Ocean by NOAA

(7) Tidal Level

This section explains the collection and analysis of tidal data, which are a necessary for the design of revetment.

1) Collection of Tidal Data

a) Observation data: The Australian Government (Bureau of Meteorology) has installed a Sea Level Fine Resolution Acoustic Measuring Equipment (SEAFRAME) at the Uliga Dock and has been continuously monitoring the tidal level since March 1993 (see Table 2.2-5).

b) Design tidal level of existing facilities: According to the BECA report, the high water level (hereinafter referred to as "HWL") of the revetment is calculated as the average sea level (hereinafter referred to as "MSL") plus 2.789 ft (0.85 m).

Table 2.2-5 Tidal Observation Station

Station number	BoM=200832 ATT=6768 WMO=91375
Observation item	Tidal level
Unit	Meter
Observation period	From 1993
Observation interval	One hour interval

Source: The Australian Government - Bureau of Meteorology

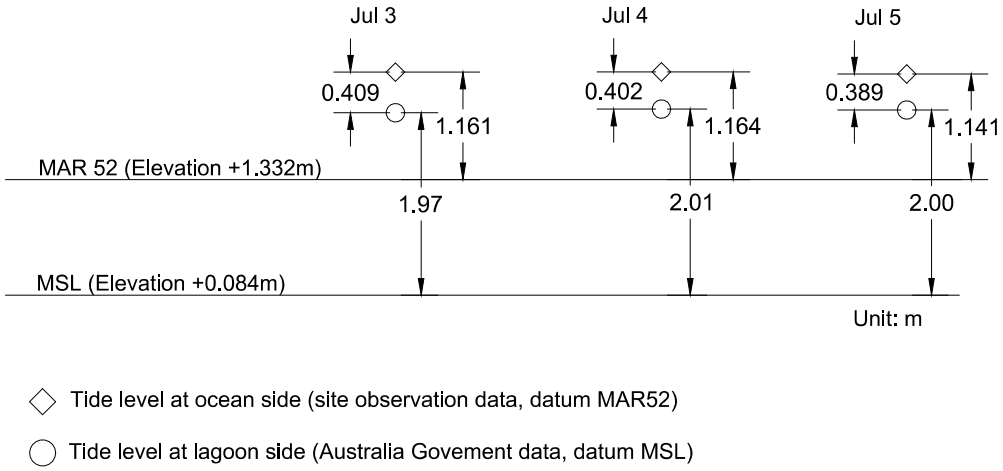
2) Analysis of Tidal Data

HWL and Low Water Level (hereinafter referred to as "LWL") were calculated based on harmonic analysis using the tidal data of the Australian Government:

HWL at lagoon side = +3.064 ft (+0.934 m)
LWL at lagoon side = -0.766 ft (-0.233 m)

However, the tidal station installed by the Australian Government is located on the lagoon side and the

Project site is located on the ocean side, which may cause differences in tidal levels. Therefore, the tidal level at the Project site was observed and compared with the existing data on the lagoon side. The observation was conducted for three days, from July 3 to July 5, 2019 at high tide (two hours before the peak and two hours after the peak).



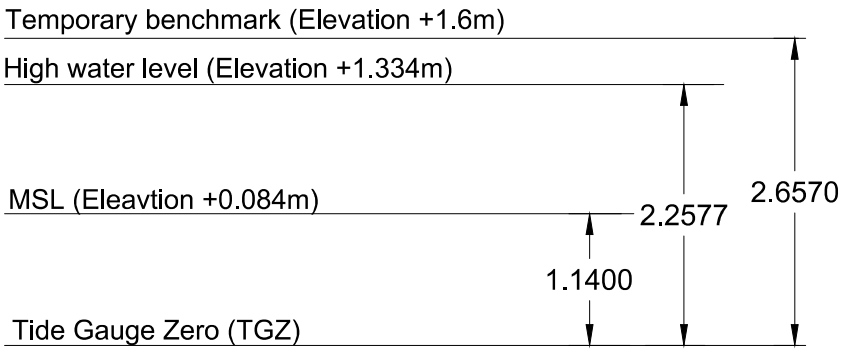
Source: JICA Survey Team

Figure 2.2-16 Differences between Lagoon and Ocean Tidal Levels

As Figure 2.2-16 shows, the difference between the lagoon side and that on the ocean side peaks is 1.312 ft (0.4 m). Therefore, for the design of revetment, the following design HWL was applied:

Design HWL (= HWL at ocean side) = HWL at lagoon side + 1.312 ft = +3.064 ft +1.312 ft = 4.376 ft (+1.334 m)

The relationship between design tidal level and the temporary benchmark is shown in Figure 2.2-17.



Note: The current project does not measure the MSL on ocean side, and the MSL on the lagoon side is shown instead.
Source: JICA Survey Team

Figure 2.2-17 Relationship between Tidal Level and Temporary Benchmark

(8) Impact of Coastal Erosion on Surrounding Area

The construction of the revetment/rainwater reservoir will not cause any coastal erosion. Therefore, the Project does not discuss countermeasures against coastal erosion.

2-2-1-3 Policy on Socio-Economic Conditions

Based on the results of the social conditions survey conducted during the preparatory survey, the policy for socio-economic conditions is set as follows.

(1) During Droughts

Majuro households not connected to public water supply service of MWSC (non-served households) secure water for domestic use by harvesting rainwater. During droughts, however, they are forced to rely on emergency water supply by sharing or purchasing from households connected to MWSC water

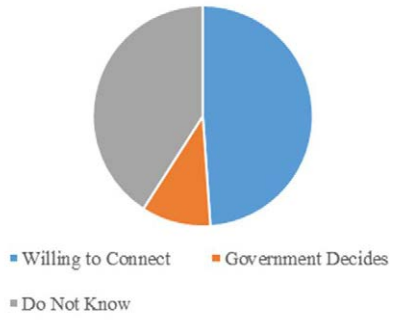
service (served households) or purchasing from water tankers. Even households connected to public water supply are affected during droughts, as water supply is restricted due to limited reservoir storage capacity.

Since groundwater is limited in Majuro, rainwater must be relied on as a water source, and rainwater must be stored as much as possible to prepare against droughts. Therefore, the proposed project site will be carefully planned to maximize its use in enabling continuous water supply even during droughts.

(2) During Normal Periods

Although served households also use rainwater, their main water source is public water supply (about 85% of the served households according to the social condition survey), but a small percentage use rainwater (about 14% of the households connected to public water supply according to the survey). On the other hand, the main water source of non-served households is rainwater. However, the social condition survey confirmed that they are willing to connect to and use public water supply services if the public water supply service is improved (about 49% of the non-served households are willing and about 10% replied that it is up to the government's decision). Figure 2.2-18 shows this relationship.

According to the survey, about 65% of served households are generally satisfied with the water supply service, but about 13% are dissatisfied with the water supply hours, and about 8% with the water volume and pressure. In order to keep households using public water supply services and consequently paying the water fees, it is essential to improve the service and increase the satisfaction. As for the non-served households and mainly rely on rainwater, they are dissatisfied most with the water quality (about 16% of the non-served households) followed by water supply volume (about 8% of the non-served households).
The Project plans to reduce the above-mentioned problems by increasing the water reservoir capacity. Specifically, for served households, improvements in water supply hours and water supply volume are anticipated, and for non-served households, solving water quality issues by connecting to public water supply services can be anticipated.



Source: JICA Survey Team

Figure 2.2-18 Willingness to Connect to Public Water Service

2-2-1-4 Construction and Procurement Policies

RMI imports all of the materials necessary for the Project, except rock and aggregates.

At the time of the expansion of the revetment nearby Majuro airport, rock from Nauru was used because it was found more economical than local rock.

However, currently there are many facility issues in loading and transporting Nauru rock, and RMIEPA has deregulated the rock quarrying in the country, increasing the use of locally produced rock. Therefore, the Project will use locally produced rock and aggregates.

American Standards (ASTM and AWWA) are applied to most of the industrial products in RMI, so the Project also applies the same standards for the materials it procures for the ease of procurement and maintenance.

2-2-1-5 Local Contractors (Construction and Consultant Companies)

A Japanese contractor will organize the construction, train and instruct local contractors in RMI.

In addition, the Contractor will rely on local contractors for some parts of the work. Two local contractors have the experience of contributing to Japanese Grant Aid projects; the two companies have the required technical capacity.

Table 2.2-6 shows the MWIU project list, and it shows that the Project is scheduled to commence construction in 2021. Judging from the budgetary arrangement for the approved projects, the volume of construction in 2021 is expected to decrease significantly compared to that of 2018 or before.

According to MWIU, even if the Project overlaps with other projects there will be no labor issues. This is because other projects are planning to procure labor from other countries, and the labor (about 30 persons) required for the Project can be secured.

Table 2.2-6 Project List

INFRASTRUCTURE DEVELOPMENT AND MAINTENANCE PLAN (IDMP) AND CASH FLOW PROJECTION FY 16-23
(as of May 16 , 2019)

Notes:

1.)Overall Compact Balance is based on **$9.30M** funding each fiscal year (actual figure varies each year)

2.)Available Compact Balance to cover A-C Projects is ($1,918,805.75)

3.)A $27.24M Funding is required for Item E Projects

4.)Landfill Project Excluded

				CASH FLOW PROJECTIONS FY 16-23							
i	Compact Funding Available (FY 14-23)		93,000,000								
	(based on ave $9.3M x 10 Years)										
ii	Compact Prior Balance (FY 08-13)		1,429,024								
	TOTAL AVAILABLE		**94,429,024**								
A	Approved Multi-Year Contract Projects	Fiscal Year	Approved Total Budget	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23
	SUB-TOTAL A PROJECTS		**61,764,698**	**5,627,041**	**6,274,935**	**7,211,377**	**7,408,122**	**6,384,630**	**10,678,580**	**10,180,012**	**8,000,000**
B	Other Approved Projects (On-going)	Fiscal Year	Approved Budget FY16-17	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23
	SUB-TOTAL B PROJECTS		**21,569,035**	**15,524,017**	**4,254,072**	**2,244,822**					
	TOTAL (A+B Fy16 to 17 + B Fy18 Projects)		**85,578,555**	**21,151,058**	**10,529,007**	**9,456,199**					

Note:Available Compact Balance is based on reconciled amount with Ministry of Finance

C	OTHER PRIORITY PROJECTS : (Needed Budget from FY19 to FY23)	Fiscal Year	Estimated Budget	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23
	SUB-TOTAL		**10,769,275**				**2,051,275**	**1,754,500**	**2,204,500**	**2,004,500**	**2,754,500**
	TOTAL A-C PROJECTS ALLOCATION PER YEAR			**21,151,058**	**10,529,007**	**9,456,199**	**9,459,397**	**8,139,130**	**12,883,080**	**12,184,512**	**10,754,500**

Source: MWIU

2-2-1-6 Policy on Operation and Maintenance Plan

(1) Revetment

MWIU has maintained the revetments required for protecting rainwater reservoir against wind waves since 1985. In future, MWIU can maintain revetments with a total length of about 335 m, in addition to the existing revetments. Therefore, technical assistance for maintenance of revetments is not required in the Project.

(2) Transmission and Storage Facilities

Currently, the rainwater collected from the rainwater collection facilities installed in the runway is directed to the pump station No.4, and then pumped to each existing rainwater reservoir. Then, the rainwater stored in each reservoir is transferred by gravity to the WTP-C through the inlet pipe which also functions as an outlet (inlet/outlet pipeline). Regarding the operation and maintenance of the rainwater reservoirs, the WTP-C section of the MWSC management department has been conducting Operation & Maintenance (hereinafter referred to as "O&M") properly since 1985, when MWSC started utilizing the rainwater reservoirs.

The reservoir planned by the Project, which will be constructed adjacent to the existing rainwater reservoir No.6, will expand the capacity of rainwater reservoirs. To transfer the rainwater to the planned reservoir, a branch line with a diameter of 14 in. (356 mm) will be installed in the existing transmission pipeline between the pump station No. 4 and the existing rainwater reservoir No. 6, and the branch and the planned reservoir will be connected by an inlet/outlet pipeline. The inlet/outlet pipeline will also transfer water from the planned reservoir to the WTP-C by gravity.

Since the operation and maintenance of the transmission and storage facilities of the planned reservoir is the same system as that of the existing rainwater reservoirs, the WTP-C section of the MWSC management department will be able to operate and maintain the new reservoir in the same way. Thus, technical assistance in the Project is assumed to be not necessary.

2-2-1-7 Policies Regarding Grades of Facilities and Equipment

(1) Design Criteria

RMI does not have its own design criteria, and the Consultant may use performance indicators and standards commonly and practically used in RMI if they are found adequate.

Table 2.2-7 shows the design criteria that the Japanese side and RMI have agreed on.

Table 2.2-7 Design Criteria

Facility	Item	Design Criteria
Rainwater Reservoir	Design Strength of the Concrete	
	-RC concrete for water tightness	● 3,625 psi (25 MPa)
	-Lean conc., leveling conc.	● 1,450 psi (10 MPa)
	-RC conc. for general work, Plain concrete	● 2,900 psi (20 MPa)
	Deformed Epoxy-coated Reinforcement Bar ASTM A775, A615 or Japan Society for Civil Engineers (hereinafter referred to as "JSCE") -E 102-2003	● Grade 60 (60ksi or 420MPa) ● Tensile strength: 90ksi (620MPa) ● Yield strength: 60ksi (420MPa) ● Bend strength: 85% of normal rebar ● Allowable dia.: 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 18, 20 in (10, 13, 16, 19, 22, 25, 29, 32, 36, 43, 57, 64 mm) →to be confirmed
	Minimum Cover (between concrete surface and rebar surface)	● 2 in. (51 mm) ● For water storage: 2.76 in. (70mm) based on the "Minimum concrete cover against effects of salt damage" of the Specification for Highway Bridge by Japan Road Association
	Design Seismic Coefficient	● Zero
	Design Wind Speed	● 142 mph (229 km/h), Risk Category III of the United Facility Criteria (UFC)
	Lining Sheet AWWA D 130, ANSI 61	● Minimum thickness: 1.5 mm ● Climate-resistance and ultraviolet rays-resistance
	Design Strength of the Concrete	

Facility	Item	Design Criteria
Revetment	-Revetment foot protection concrete	● 4,352 psi (30 MPa)
	- RC concrete, site concrete	● 2,610 psi (18 MPa)
	- Deformed Epoxy-coated rebar	● Grade 60 (60 ksi or 420 MPa)
	ASTM A775, A615 or JSCE-E 102-2003	● Tensile strength: 90 ksi (620 MPa)
		● Yield strength: 60 ksi (420 MPa)
		● Bend strength: 85% of normal rebar
		● Allowable dia.:3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 18, 20 in (10, 13, 16, 19, 22, 25, 29, 32, 36, 43, 57, 64 mm)
	Rock	● 3-6 tons of armor rock
	Filter Layer	● 100–250 kg of crush rock
	Minimum Cover (between concrete surface and rebar surface)	● 2.76 in. (70 mm) based on the "Minimum concrete cover against effects of salt damage" of the Specification for Highway Bridge by Japan Road Association
	Design Strength	● None
	Design Wave	● 50 years
	Design Life	● 50 years
	Type of Revetment	● Rubble mound structure
	Slope of Revetment	● Ocean side: 1:2.5
		● Lagoon side: 1:1.5
Pipeline	Inlet/Outlet Pipe	Straight Pipe ● Material: PVC ● Standards: AWWA C905 ● Pressure class: DR18 Fittings ● Material: DIP ● Standards: AWWA C153 ● Pressure class: 350 psi
	Sub-drain Pipe (under the lining of the proposed rainwater reservoir)	● Material: Perforated PVC ● Standards: ASTM D3034 ● Pressure class: SDR35
	Drain Pipe	● Material: PVC ● Standards: AWWA C900 ● Pressure class: DR18
	Air Ventilation Pipe	Underground sections ● Material: PVC ● Standards: ASTM D2729 Above-ground sections ● Material: DIP ● Standards: AWWA C110 ● Pressure class: 250 psi
	Overflow Pipe	● Material: DIP ● Standards: AWWA C110/153 ● Pressure class: 350 psi
	Valve	● Body material: Ductile iron with epoxy coated interior and exterior surface ● Head: 2" square wrench nut ● Type of joint: Flange ● Type of Valve: ● Gate valve : 12" and under: ● Butterfly valve: 14" and over:
	Valve Box	● Material: ● Box cover: Cast iron/aluminum ● Box top: Cast iron /aluminum ● Riser: SDR 35 PVC
	Minimum Depth of Pipeline of Transmission Pipeline	● 3 ft (0.91m)
	Prevention of Joint Separation	● Valve and an inlet/outlet pipe sections: Concrete block ● Branch between existing pipes and vertical offset: Restrained joint

Source: JICA Survey Team prepared based on information from MWIU and MWSC

(2) Revetment Design

The crown crest height was determined considering an offshore wave with a 50-year return period, and

sea level rise in 50 years (0.76 ft or 23 cm).

When using stone for the revetment, its impact on the ocean environment (e.g. coral reefs) must be considered. Therefore, the following design principles were specified:

- Quantity of the stone should be reduced as much as possible
- Impacts of quarrying rocks and the total constriction cost must be balanced
- Harmony with the concrete retaining wall must be considered

(3) Rainwater Reservoir Design

The structure of the proposed rainwater reservoir is designed in the same way as those of the existing rainwater reservoirs. The reservoir covers an area of 5.7 ac (2.3 ha) which is surrounded by the existing rainwater reservoir No. 6, Iakwe Katoj Park, the eastern boundary fence of Majuro International Airport and reef edge. Its maximum capacity is limited to around 15 MG (56,900 m^3) by the above land condition.

(4) Pipelines Design

The pipeline equipment including pumps and valves is selected by considering the specifications and operability of the existing pipelines.

2-2-1-8 Construction Term and Construction & Procurement Method

(1) Construction Method

The Project consists of the construction of revetments, a rainwater reservoir and pipelines. The revetments will be constructed first, followed by the rainwater reservoir, and finally the pipelines. The construction method of each Project component is as follows.

1) Revetment

The proposed revetment will be constructed by the following steps:

- Install crushed stone behind the proposed revetments.
- Install rock by rough terrain crane after the construction of the access stage by utilizing large sandbags and iron plates.
- Construct concrete retaining wall.

A contractor will purchase ready-mixed concrete and place it using rough terrain cranes.

In addition, the Contractor should prevent cold joint, place concrete at night, place concrete within one and a half hours after the mixing, and place consolidated fresh concrete within two hours.

2) Rainwater Reservoir

The proposed rainwater reservoir is composed of an embankment and a reverse T-shaped retaining wall on the embankment, following the structure of the existing rainwater reservoir.

The rainwater reservoir concrete will be placed in a way similar to that of the revetment parapet construction by a rough terrain crane.

In order to prevent water leakage from the proposed rainwater reservoir, lining sheet will be placed inside the rainwater reservoir.

The Contractor will join sheet ends at the site with an overlap of approx. 100 mm, and heat-sealing 40 mm or more of the sheet.

3) Pipelines

PVC pipes will be laid at the bottom of the proposed rainwater reservoir. The PVC pipes should be applied against condition of corrosion. In addition, ductile cast iron pipes will be used at bends, tees, etc., apart from straight pipes. Ductile pipes will be covered with poly-ethylene sleeves to prevent them from corrosion. The pipes will be laid by using an excavator with a capacity of 0.28 m^3.

(2) Procurement Policy

Construction materials, such as concrete, rock, aggregate, will be, basically, procured locally, but other materials such as rebar and piping materials which are not locally available, will be procured from Japan and/or third countries.

Epoxy-coated rebar, which is corrosive resistant, will be used for the concrete work along the seaside.

(3) Construction Period

The construction period will be as follows:

- Detailed design: five months
- Tender announcement and contract: four months
- Construction: 22 months

2-2-2 Basic Plan

2-2-2-1 Revetment

This section discusses first the input data necessary for the basic design of the revetment, specifically the design wave, the design tidal level, and sea level rise. Then it examines the stability of the revetment against waves.

(1) Plainview

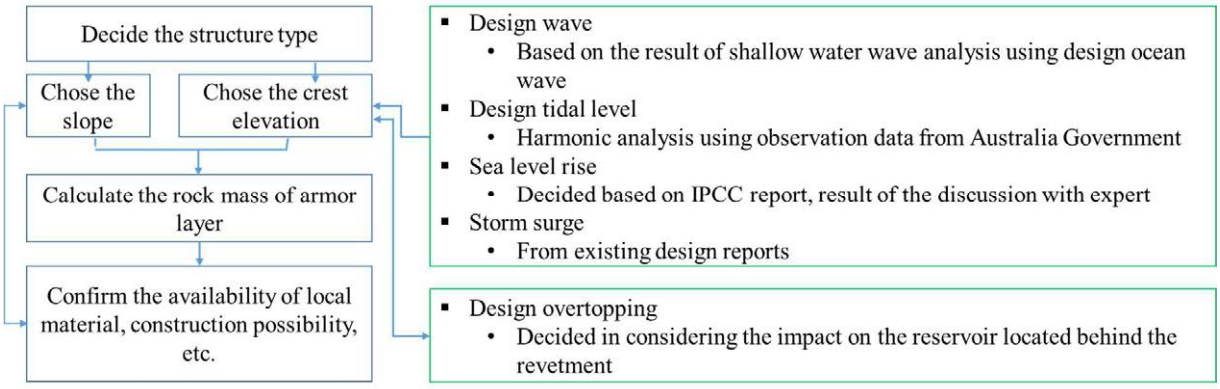
The location of the revetment was determined in consideration of the following points:

- Geology: In order to examine the long-term stability of revetment, soil investigation was conducted at the three locations shown in Figure 2-2-7. According to the SPT results shown in Table 2-2-2, a top layer of sand and gravel with an N-value of 10 or more continues to a depth of 23 m at all three locations. Therefore, there will be no significant ground subsidence, and it can be judged that the Project does not need to consider ground improvement. In addition, there will be no impact on the study of the revetment alignment.
- Construction cost: When the revetment is moved toward the ocean side, there will be more space for the construction of the rainwater reservoir. However, the design wave will be larger, and this will make a higher revetment necessary, consequently increasing the construction cost.
- Coastal erosion: For a long-term use of the revetment/rainwater reservoir, the facilities should be constructed in the area where coastal erosion does not occur. Since the Project site is surrounded by coral reef, the impact of coastal erosion is considered below.

Accordingly, the alignment of the revetment is determined in consideration of the balance between securing the design capacity and the construction cost of the rainwater reservoir.

(2) Structure of Revetment

The type of the revetment structure was determined considering based on the stability of revetment, availability of local materials, feasibility and cost of construction, etc. (see Figure 2.2-19).



Source: JICA Survey Team

Figure 2.2-19 Process of Revetment Structure Examination

The design conditions and the detail of the revetment structure design are as follows:

Design time life of revetment: 50 years

The return period of design wave: 50 years

Examination of crest level:

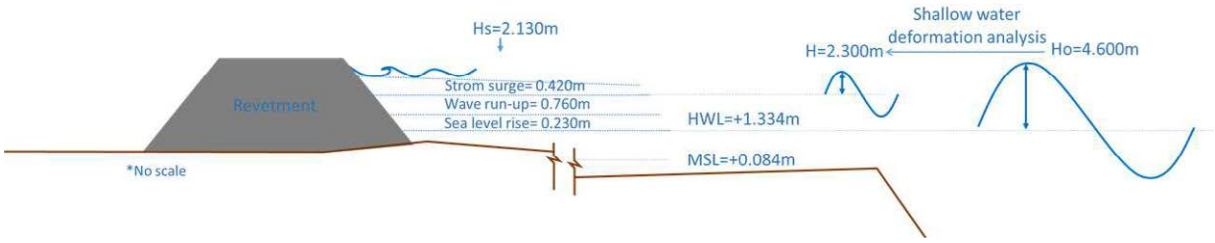
The crest level of the revetment is calculated based on the sea level rise rate, the design HWL, and the design waves. The crest level also should be decided so that the overtopping rate is lower than the design-overtopping rate specified based on the importance of hinterland (see Figure 2.2-20).

- Design wave (see 2-2-1-2 (5))
  - Design ocean wave Ho = 15.091 ft (4.6 m); T = 9.6 (s)
  - Design wave Hs = 6.988 ft (2.13m); T = 9.6 (s)
- Design tidal level (see 2-2-1-2 (7))
  - HWL = +4.377 ft (+1.334 m)
  - LWL = +0.275ft (+0.084 m)
- Sea-level rise = 0.755 ft (0.23 m)/50 years (see 2-2-1-2 (6))
- For the storm surge, the Project referred to the existing design reports. According to the BECA (an Australian consulting firm) report of Majuro International Airport expansion project, a storm surge with a return period of 50 years (1.378 ft or 0.42 m) is adopted.
- The overtopping amount is limited to 0.01m^3/s /m considering the impact on the rainwater reservoir located behind the revetment (see Table 2.2-8).
- Crest level = HWL + Sea level rise + Wave run-up + Storm surge + Free board

Table 2.2-8 Allowable Overtopping Flow Rate based on the Importance of the Hinterland

Regions with a high population density or public facilities which may results in hug damage	About 0.01 m^3/m/s
Other important regions	About 0.02 m^3/m/s
Other regions	About 0.02–0.06 m^3/m/s

Source: Shichirou Nagai, Akira Takada: Effects of wave breakwater on overtopping of the coastal dike, 11th Coastal Engineering Proceeding, pp.279-286 (in Japanese)



Source: JICA Survey Team

Figure 2.2-20 Examination of Crest Level

Selection of structure type:

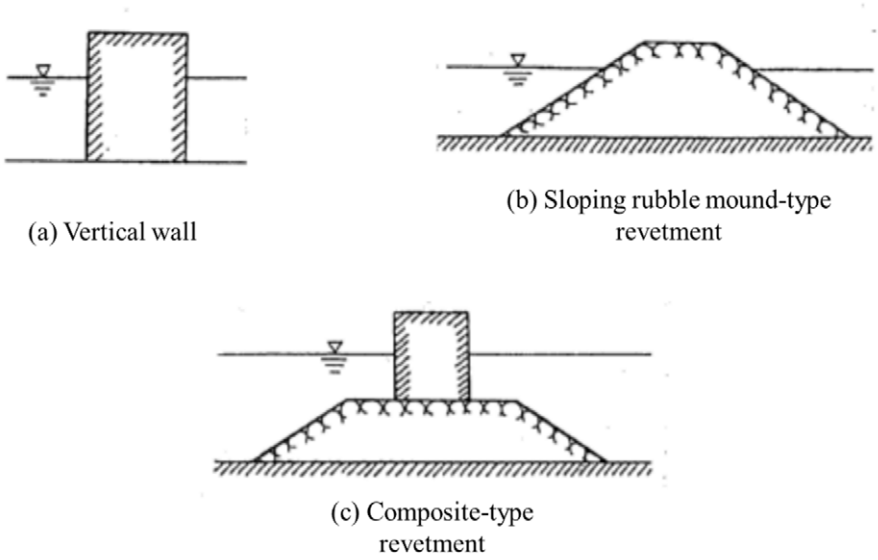
There are three types of revetments: vertical seawall, sloping rubble mound-type revetment, and composite-type revetment (see Figure 2.2-21). Table 2.2-9 and Figure 2.2-22 show the pros and cons as well as the construction cost of each type of revetment.

The current project adopted sloping rubble mound-type revetment for the following reasons:

- The sloping rubble mound-type revetment can reduce overtopping volume as well as wave run-up height more compared to the vertical wall type.
- The sloping rubble mound-type revetment resists more the wave energy in case wave breaking occurs in front of the structure[9].

9Technical standards and explanation of coastal conservation facilities (2018 edition)

- Most of the revetments in the adjacent areas are sloping rubble mound-type revetments.



Source: Technical standards and guidelines for costal protection facilities

Figure 2.2-21 Types of Revetment Structures

Table 2.2-9 Comparison of Revetments Structures

Type	Structure type	Pros	Cons	Construction cost (mil/m)
Type 1	Wave dissipating seawall + Armor layer	● Since the width of the revetment body is narrow, a large reservoir area can be secured.	● Because the wave-dissipating seawall is below the HWL, the construction process should be developed considering the tidal circle, which increases the construction period. ● Wave-dissipating seawall is below the LWL, requiring the use of underwater concrete, and resulting in the increase of construction cost.	75
Type 2	Parapet + Armor layer	● Since the parapet is higher than HWL, the construction period can be shortened without being affected by the tidal circle.	● The capacity of the rainwater reservoir is limited compared to the vertical wall type.	63
Type 3	Sloping rubble mound	● Since the structure is composed of only stone, the construction is easy.	● The capacity of rainwater reservoir is reduced due to the larger revetment.	115

Source: JICA Survey Team

Details of the revetments are shown in Table 2.2-10.

Table 2.2-10 Specifications of Revetments

Facility	Description
Revetment	・Parapet: On-site cast concrete, L= 1,099 ft (335m) ・Amor rock: 4-6 tons coral rock,

Facility	Description
	625 kg rubble stone ・Maintenance road Concrete pavement: B=10ft (3.048 m), L=1,099 ft (335 m) ・Drainage facility Manholes: Concrete cast on site, B*L=2.3 ft*2.3 ft (0.7 m*0.7 m) Manhole cover: stainless steel, B*L=2.3 ft*2.3 ft (0.7 m*0.7 m) Drainage channel: onsite cast concrete, B*L=1 ft*1 ft (0.3 m*0.3 m) ・Overflow pipe PVC, diameter 8 inches (200 mm)

Source: JICA Survey Team

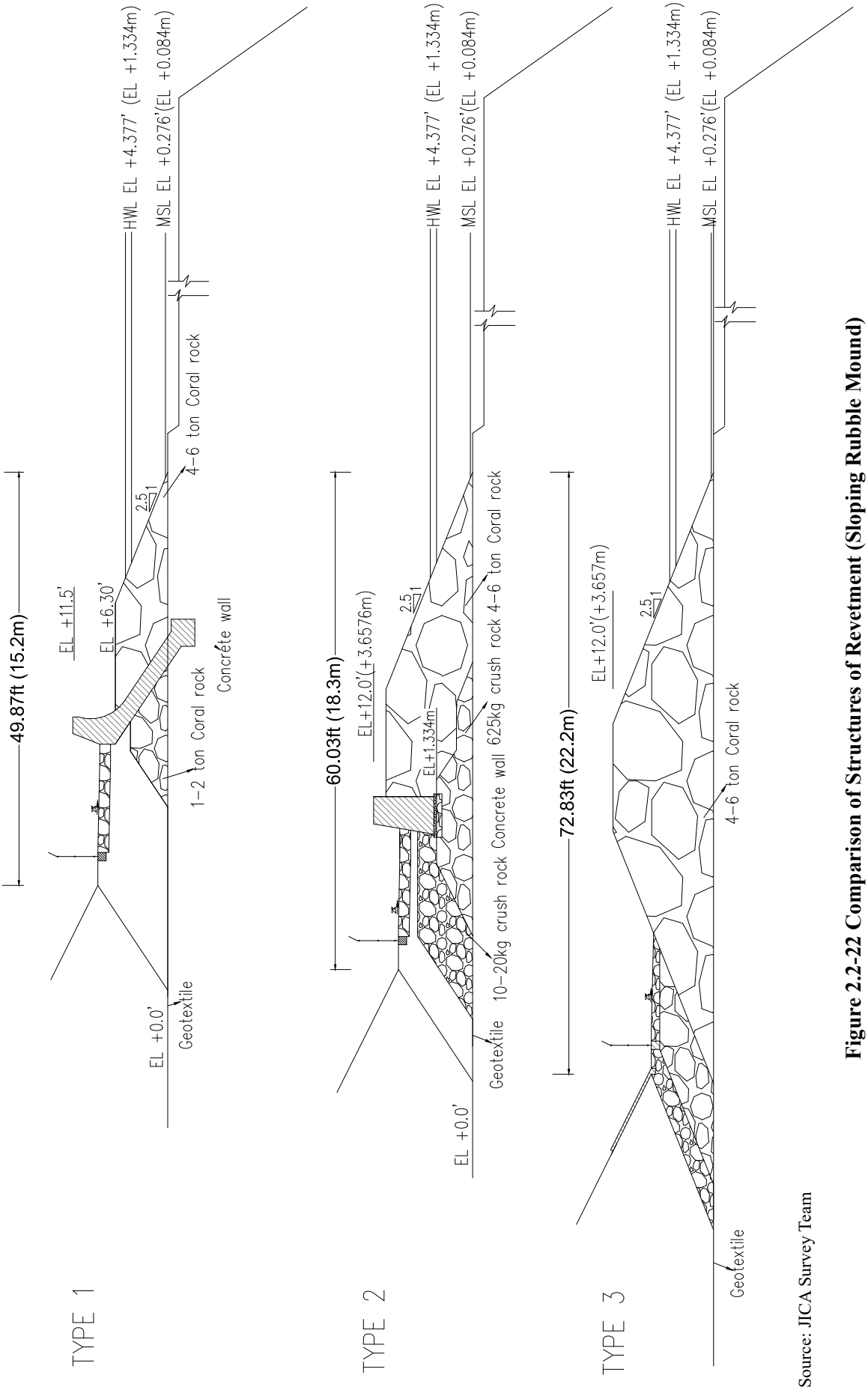


Figure 2.2-22 Comparison of Structures of Revetment (Sloping Rubble Mound)

Source: JICA Survey Team

(3) Maintenance Road

- Width of maintenance road is 10 ft (3.048 m)
- For the pavement, reinforced concrete pavement is chosen because the road is located right behind the revetment allowing overtopping.
- Structure of pavement is specified according to the Pavement Construction Manual of Japan Road Association for traffic load T<100 and California Bearing Ratio (CBR) =10:
  - Base-course thickness is 0.5 ft (0.1524 m)
  - Concrete pavement thickness is 0.5 ft (0.1524 m)

(4) Drainage

- Design the standard section: draining of overtopping seawater and rainwater
- Design load: 10 ton vehicle
- Material: reinforced concrete
- Design strength of concrete: σck=24 N/mm^2
- Design rainfall intensity: 156.4 mm / hour (10-minute rain with a 5-year probability)

2-2-2-2 Rainwater Reservoir

As noted earlier, the surface area of the proposed rainwater reservoir is around 5.7 ac (2.3 ha), and it is surrounded by the existing rainwater reservoir No. 6, Iakwe Katoj Park, the eastern boundary fence of Majuro International Airport and reef edge as shown in the red frame in Figure 2.2-23. This area is limited by the above land condition. The capacity of the proposed rainwater reservoir was designed based on the proposed layout of revetment along reef edge. The clearance between the eastern boundary fence of Majuro International Airport and the proposed facility perimeter is 11 ft (3.35 m) in accordance with the agreement with the Civil Aviation, RMIPA.

Source: JICA Survey Team

Figure 2.2-23 Layout of Proposed Rainwater Reservoir

An optic fiber cable is installed under the maintenance road between the existing revetment and the rainwater reservoir No. 6 by National Telecommunication Authority (hereinafter referred to as "NTA") as shown in Figure 2.2-24. After discussion, the NTA, MWIU, MWSC and the Team agreed that it is safe to construct the proposed rainwater reservoir over this optic fiber cable, and they also agreed on the concept of construction. Since the cable is in a PVC conduit with a nominal diameter of four in., it will not be affected by the surplus vertical load.

Source: NTA (compiled by JICA Survey Team)

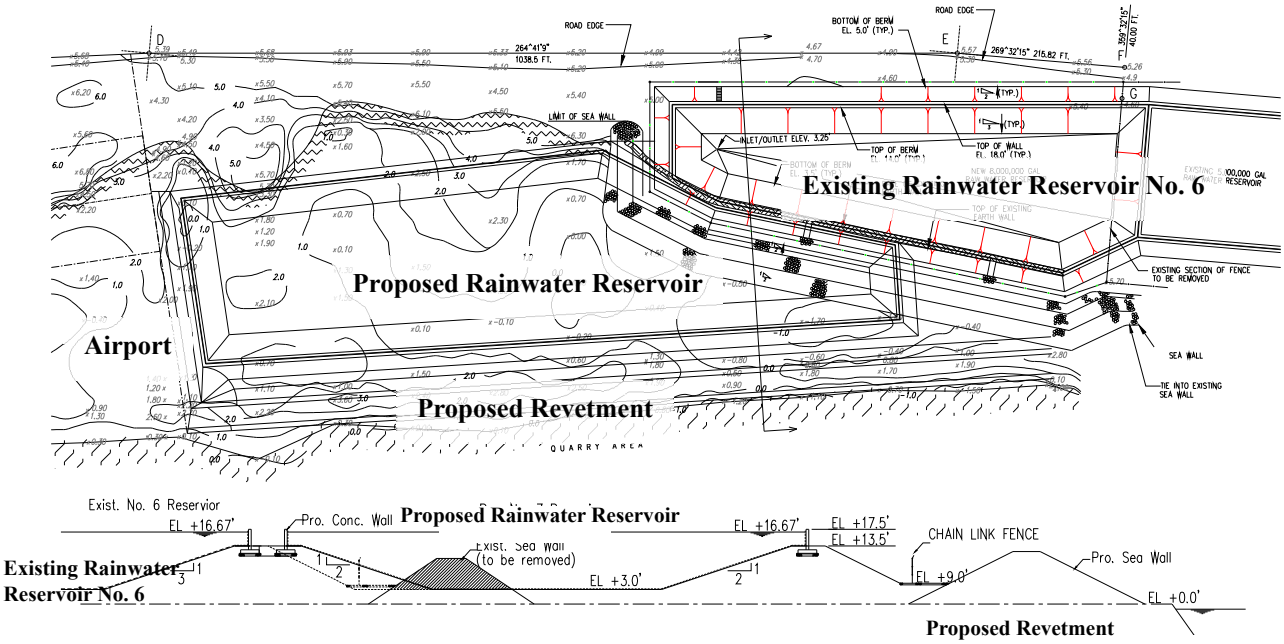
Figure 2.2-24 Layout of Optic Fiber Cable

(1) Structural Type of the Reservoir

Three types of reservoir structure are technically and financially examined, namely, (1) Embankment + Inverted T-retaining Wall, (2) Inverted T-retaining Wall and (3) Rectangular Tank. The first two types need a sheet lining at the bottom and side of the rainwater reservoir for waterproofing.

Alternative-1: Embankment + Inverted T-retaining Wall Type

Embankment plus inverted T-retaining wall structure type is the same as that of the existing rainwater reservoirs as shown in Figure 2.2-25. The capacity of this type is 15.0 MG (56,900 m^3). The inner slope of the embankment was changed from 1:3 to 1:2 in order to increase the capacity without affecting its stability.



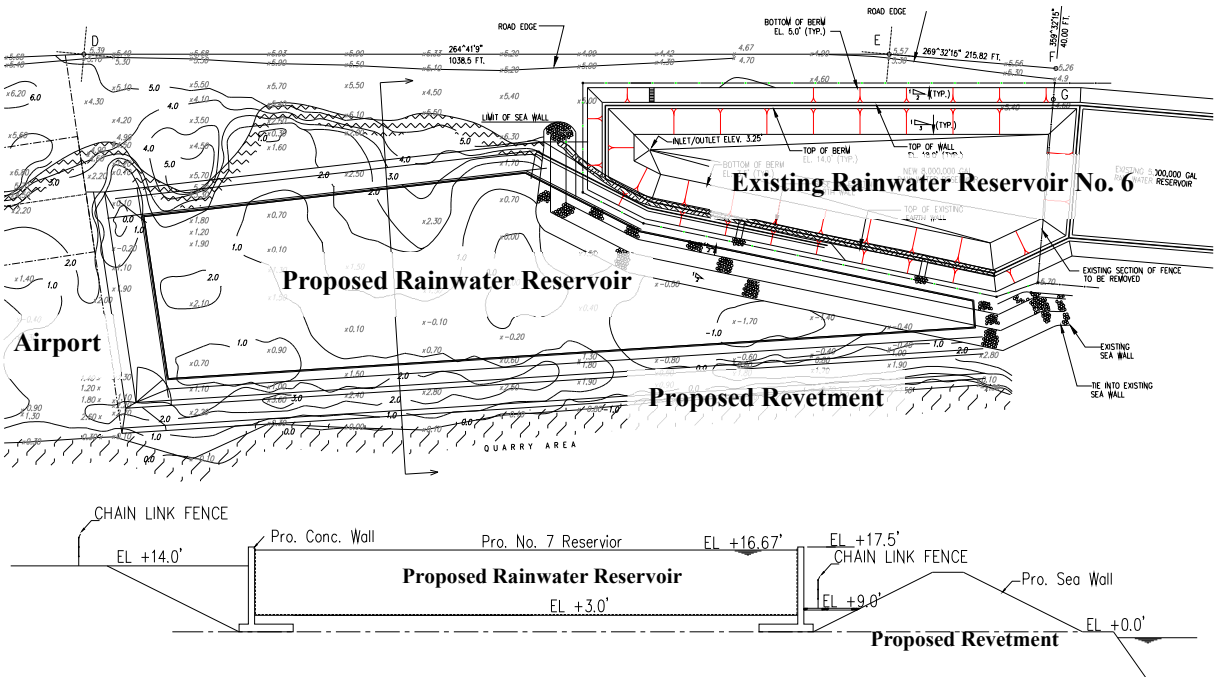
Source: JICA Survey Team

Figure 2.2-25 General Plan and Sectional View of Alternative-1 (Embankment plus T-retaining Wall Type)

Alternative-2: Inverted T-retaining Wall Type

Inverted T-retaining wall structure type is as shown in Figure 2.2-26. The capacity of this type is 17.8

MG (67,541 m^3).

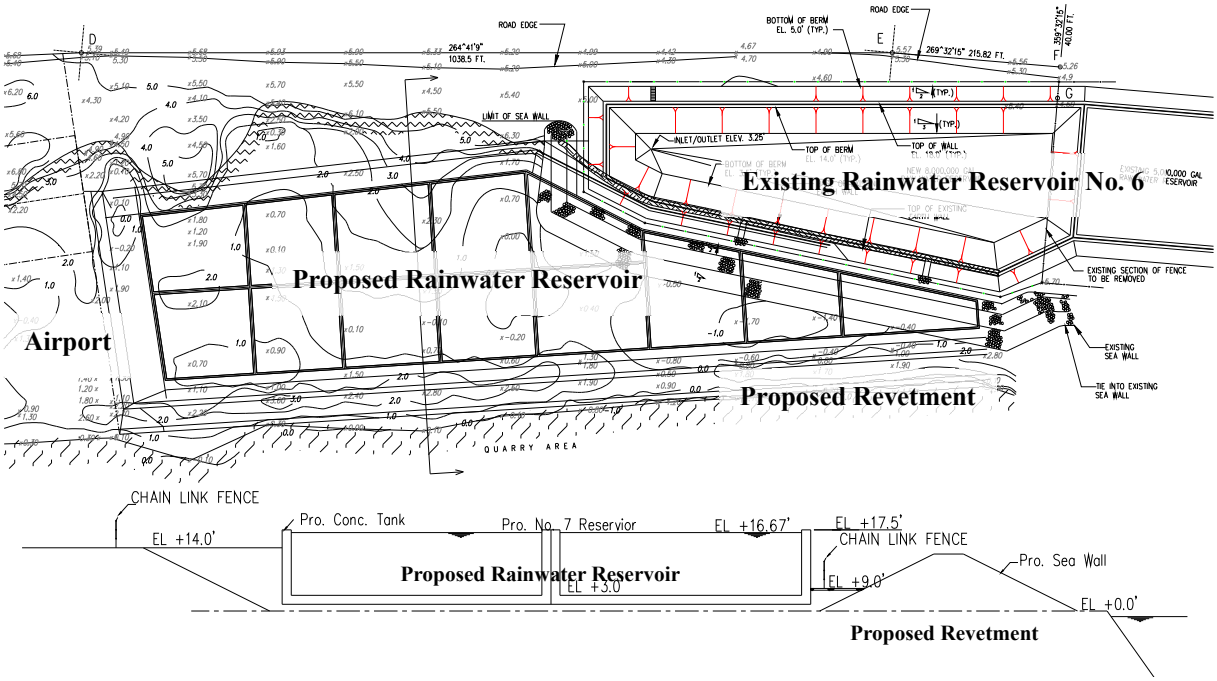


Source: JICA Survey Team

Figure 2.2-26 General Plan and Sectional View of Alternative-2 (Inverted T-retaining Wall Type)

<u>Alternative-3: Rectangular Tank Type</u>

Rectangular tank structure type is as shown in Figure 2.2-27. The capacity of this type is 15.8 MG (59,765 m^3).



Source: JICA Survey Team

Figure 2.2-27 General Plan and Sectional View of Alternative-3 (Rectangular Tank Type)

After comparing the three alternatives as shown in Table 2.2-11, Alternative-1, Embankment plus T-retaining wall, which is the same as the existing rainwater reservoir, is selected for the Project mainly

because it is the lowest cost option. Other aspects such as construction period, and ease of and familiarity with the operation and maintenance system are also considered for selecting structural type.

- The capacities of the three alternatives are not significantly different.
- Alternative-3 has more advantages than the other two alternatives in terms of water tightness, and does not need the lining sheet.
- Alternative-1 has more advantages than the other two alternatives in terms of cost because it needs less concrete volume and shorter construction period.

Table 2.2-11 Comparison of Structural Types

Items	Alt.-1: Embankment & Inverted T-retaining Wall Type (the same as the existing)	Alt.-2: Inverted T-retaining Wall Type	Alt.-3: Rectangle Tank Type
1. General			
(1) Expected Capacity	15.0 MG (56,900 m^3) (1.00)	17.8 MG (67,541 m^3) (1.19)	15.8 MG (59,765 m^3) (1.05)
(2) H.W.L. of the Reservoir	EL16.67 ft (5.081 m)	EL16.67 ft (5.081 m)	EL16.67 ft (5.081 m)
(3) Bottom of the Reservoir	EL3.00 ft (0.914 m)	EL3.67 ft (1.118 m)	EL3.67 ft (1.118 m)
2. Rough Amount			
(1) Reinforced Concrete	15,126 ft^3 (423 m^3) (1.0)	96,146. ft^3 (2,723 m^3) (6.4)	672,701 ft^3 (19,049 m^3) (44.5)
(2) Embankment	894,421 ft^3 (25,327 m^3) (1.0)	941,054 ft^3 (26,648 m^3) (1.1)	941,054 ft^3 (26,648 m^3) (1.1)
(3) Lining Sheet	186,848 ft^2 (17,196 m^2) (1.0)	207,112 ft^2 (19,061 m^2) (1.1)	Unnecessary
3. Technical Aspects			
(1) Water Tightness	Inferior to Alt.-3 in water tightness and needs a lining sheet.	Same as Alt.-1	Superior to other alternatives in water tightness and does not need a lining sheet.
(2) Workability	It needs the construction of Inverted T-retaining Wall after embankment. However, the construction period is shorter than the other alternatives because of less volume of concrete casting.	Embankment is not needed. However, the construction period is longer because the volume of concrete casting is 6 times that of Alt.-1.	Embankment is not needed. However, the construction period is much longer because the volume of concrete casting is 45 times that of Alt.-1.
4. Economic Aspects			
(1) Construction Cost per Unit Capacity	(1.0)	(2.7)	(17.4)
(2) Economical Efficiency	The most economical in terms of construction cost per unit capacity.	Less economical because the construction cost is 3 times that of Alt.-1.	Least economical because the construction cost is 17 times that of Alt.-1.

Notes: 1) The number in the parentheses shows the ratio when the amount of Alt.-1 is assumed as one.
2) "EL" means the elevation.

Source: JICA Survey Team

Details of the rainwater reservoir are shown in Table 2.2-12.

Table 2.2-12 Specifications of Rainwater Reservoir

Facility	Description
Rainwater	Embankment & Inverted T-retaining Wall (Same structure as the existing rainwater

Facility	Description
Reservoir	reservoirs): One reservoir ・Storage capacity: 15.0 MG (56,900 m^3) ・HWL：EL16.67 ft (5.081 m) ・Elevation at the bottom of the rainwater reservoir: EL3.00 ft (0.914 m) ・Surface area×Depth of the reservoir: approx. 172,500 ft^2×13.67 ft (16,000 m^2×4.17 m) ・Embankment: Filling（Slope gradient: 1:2） ・Inverted T-retaining Wall: Reinforced concrete, H = 4.921 ft (1.5 m) ・Inside reservoir: Lining sheets & continuous fiber non-woven fabric

Source: JICA Survey Team

(2) Lining Sheet

Lining sheet is laid inside the proposed rainwater reservoir in order to prevent water leakage. The lining sheet specification is climate-resistance and ultraviolet rays-resistance as shown in Table 2.2-7.

(3) Cover on Proposed Rainwater Reservoir.

Based on rough calculation by the Team, evaporation from the proposed rainwater reservoir was estimated at 0.37 ft (11.3 cm)[10] per month in the depth of the proposed rainwater reservoir. Although installation of cover on the rainwater reservoir such as shade balls was examined by the Team, the Project does not include any covers such as shade balls from aspect of not only material cost but also efficiency and sustainability because shade balls must be removed partially, while solar power generation system is installed in the proposed rainwater reservoir in future.

(4) Confirmation of Operational Feasibility of the Proposed Rainwater Reservoir (Relationship with Rainfall, Water Storage Capacity and Water Demand)

The operational feasibility of the proposed rainwater reservoir was confirmed whether there is enough supply capacity for the estimated water demand as of 2019, and the reservoir can be filled and effectively operated.

The following table shows a water balance at WTP-C.

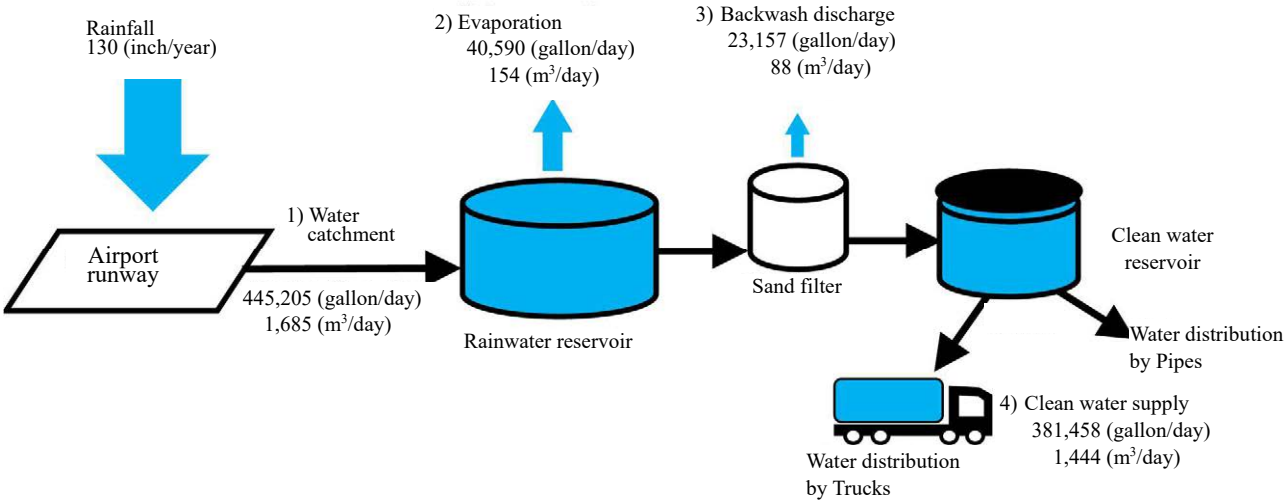
Table 2.2-13 Water Balance at WTP-C

Item	Calculation Basis	Value	Remarks
Airport runway water catchment (gallon/day)	1) Water catchment amount per one inch rainfall (1.25 MG/inch) x daily average rainfall [130 (inch/year) ÷ 356 (days)]	445,205	Average annual rainfall: 130 inch/year
Same as above (m^3/day)		1,685	
Volume of evaporation in the reservoirs (gallon/day)	2) 3.76 (mm/day) ÷1000 × 40,860 (m^2) x 1000/3.785 (liter/gallon)	40,590	Water surface area of total reservoirs: 40,860 m^2
Same as above (m^3/day)		154	
Backwash discharge of sand filter (gallon/day)	3)	23,157	
Same as above (m^3/day)		88	
Capacity of clean water supply (gallon/day)	4) = 1) - 2) - 3)	**381,458**	
Same as above (m^3/day)		1,444	
Water demand (gallon/day)	5)	**113,572**	*
Same as above (m^3/day)		429	
Supply capacity margin (gallon/day)	6) = 4) - 5)	**267,886**	
Same as above (m^3/day)		1,015	

Source: JICA Survey Team

* In order to calculate the water demand in the WTP-C area, the water demand in Laura area is deducted from the total quantity of water demand (120,822 gal/day) as of 2026 in Majuro at the annual average precipitation of one in./month. The water demand was based on the same process as shown in Table 4.4-6 and Table 4.4-7. Laura's water distribution in 2018 was approximately 6% of Majuro's total, so the water demand in the WTP-C area is 120,822 × (100-6) /100 = 113,572 (gallon/day).

[10] Based on Hamon formula::Ei = 0.14(N/12)2qi, Ei: Average Evaporation per day (mm/day), N: Sunshine Duration (hours), qi: Absolute Humidity at average daily temperature (g/m^3)



Source: JICA survey team

Figure 2.2-28 Water Balance at WTP-C

Comparing with the amount of water demand 5) and the capacity of clean water supply 4) in Table 2.2-13, there is a margin of 267,886 gallon/day (1,015 m^3/day) for the capacity of clean water supply. Converted to yearly volumes, the margin is 97 MG/year (370,091 m^3/year) in yearly supply capacity, [267,886 (gallon/day) × 365 (days) = 97,778,390 (gallon/year)]. It means that there is enough capacity through the year. The capacity of the existing reservoirs is 36.5 MG (138,168 m^3) for raw water and clean water, and 15 MG (56,781 m^3) for the proposed reservoir. The total capacity is 51.5 MG (194,949 m^3). The margin in yearly supply capacity of 97 MG (370,091 m^3) is larger than the total capacity of the reservoirs. Therefore, it is confirmed that the proposed rainwater reservoir can be filled up and effectively operated even if the proposed reservoir is constructed (see Figure 2.2-28).

2-2-2-3 Transmission Facilities

(1) Transmission Pipelines (Inlet/Outlet Pipeline)

To transfer the rainwater to the proposed rainwater reservoir, a branch with the same diameter as the existing pipe (14 in. or 356 mm) will be installed in the existing transmission pipeline between the pump station No. 4 and the existing rainwater reservoir No. 6, and the branch and the proposed rainwater reservoir will be connected by a new inlet/outlet pipeline. The inlet/outlet pipeline will also transfer water from the rainwater reservoir to the WTP by gravity.

(2) Sub-drain Pipeline and Drainage Pipelines

Under the lining sheet of the existing rainwater reservoir, sub-drain pipelines are installed to drain the water leaked through the lining sheet. In the Project, the same type of sub-drain pipelines will be installed under the lining sheet of the planned reservoir. In addition, these sub-drain pipelines eliminate uplift pressure at high tide and during sea level rise. In order to drain the collected water to the lagoon side, drainage pipelines will be connected to the existing drainage pipeline of the existing rainwater reservoir No.6.

(3) Air Ventilation Pipelines

Air ventilation pipelines will be installed in the embankment of the planned reservoir to eliminate uplift pressure at high tide and during sea level rise. The pressure is created because the current high water level on the ocean side is higher than the bottom level of the planned reservoir and also sea level rise is expected due to the effects of climate change.

(4) Overflow Pipelines

An overflow pipe will be installed in case excessive water is pumped from the pump station No.4 and/or rain falls, when the rainwater reservoir is full.

Details of the pipeline facilities are shown in Table 2.2-14.

Table 2.2-14 Specifications of Pipeline Facilities

Facility	Description
Transmission pipeline (Inlet/Outlet pipeline)	・ Pipe Material and Quantity: PVC DN 14 in. (356 mm), L = 75 m Since soils surrounding pipe can be affected by seawater, MWSC has normally used PVC which has no risk of corrosion. Thus PVC will also be adopted in the Project. ・ Minimum Depth of Cover: 3 ft (91 cm) which is adopted by MWSC. ・ Prevention of Joint Separation: Measures will be taken to prevent joint separation. Valve and an inlet/outlet pipe Sections: Concrete block Branch between existing pipes and vertical offset: Restrained joint ・ Ancillary Facilities: Butterfly valve DN 14 in. (356 mm), 1 unit ・ Remarks: Regarding fittings, MWSC has normally used DIP instead of PVC. Thus, DIP fittings will also be adopted in the Project. In addition, in order to minimize corrosion, the fittings will be wrapped with polyethylene encasement.
Sub-drain pipeline and drainage pipeline	Water leakages from the lining sheet will be collected by perforated pipes (DN 4 in. or 102 mm) laid under the sheet and transferred by drainage pipeline of DN 8 in. (203 mm) and 12 in. (305 mm). ・ Pipe Material and Quantity: Sub-drain pipe: Perforated PVC DN 4 in. (102 mm), L = 830 m Drainpipe: PVC DN 8 in. (203 mm), L = 280 m; PVC DN 12 in. (305 mm), L = 105 mm ・ Minimum Depth of Cover: Each depth will be set as follows: DN 4 in. (102 mm): 6 in. (154 mm) DN 8 in. (203 mm) and DN 12 in. (305 mm): 1 ft (305 mm) ・ Prevention of Joint Separation: Measures will be taken to prevent joint separation. Valve sections: Concrete block ・ Ancillary Facility: Gate valve DN 12 in. (305 mm), 1 unit
Air Ventilation Pipeline	・ Pipe Material and Quantity: Perforated PVC DN 3 in. (76 mm), L = 8.2 m × 40 units DIP DN 3 in. (76 mm) will be used for above-ground sections
Overflow Pipe	・ Pipe Material and Quantity: DIP DN 6 in. (152 mm), L = 71 m

Source: JICA Study Team

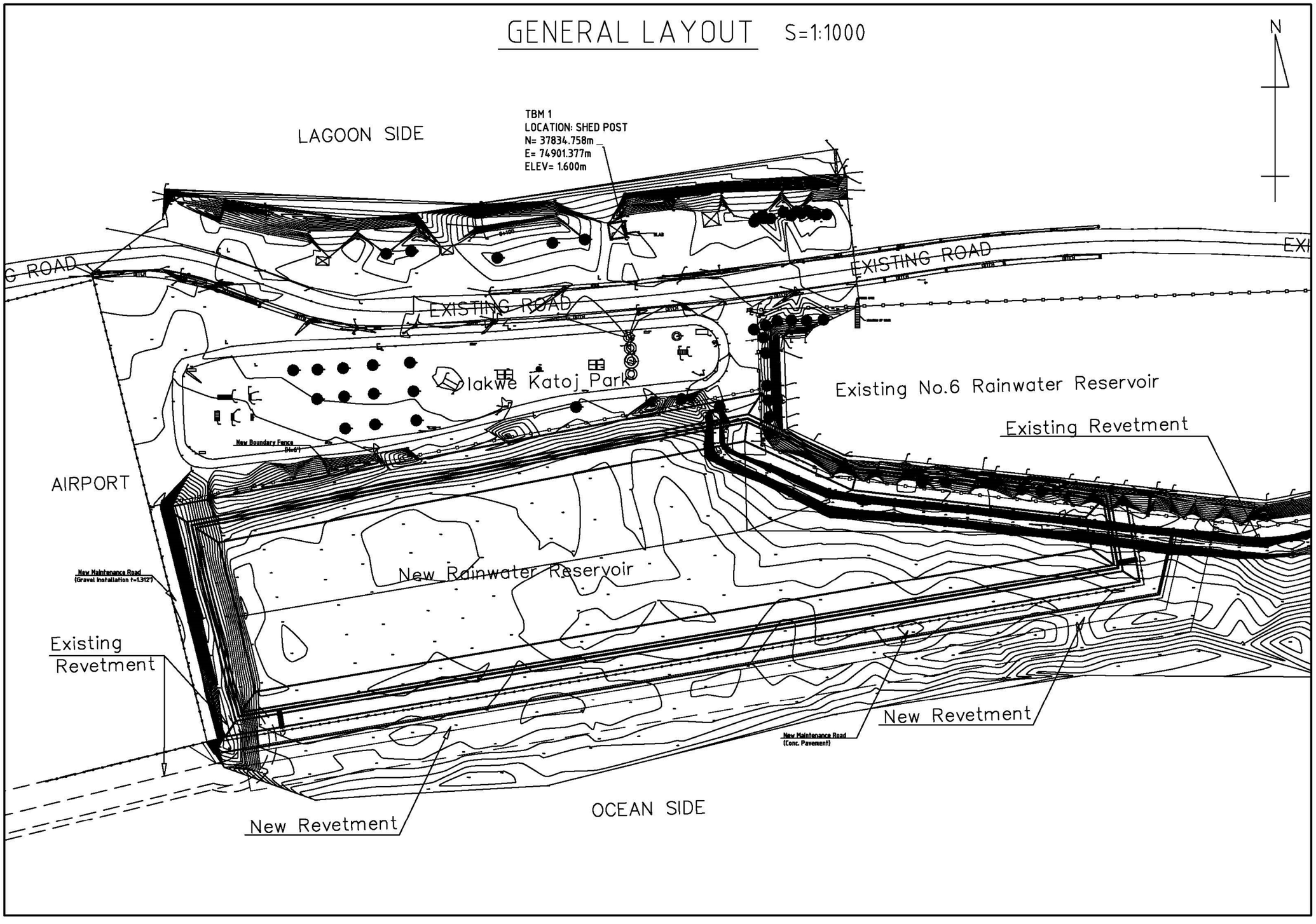
2-2-3 Outline Design Drawing

Table 2.2-15 shows a list of outline design drawings for the facilities to be developed in the Project.

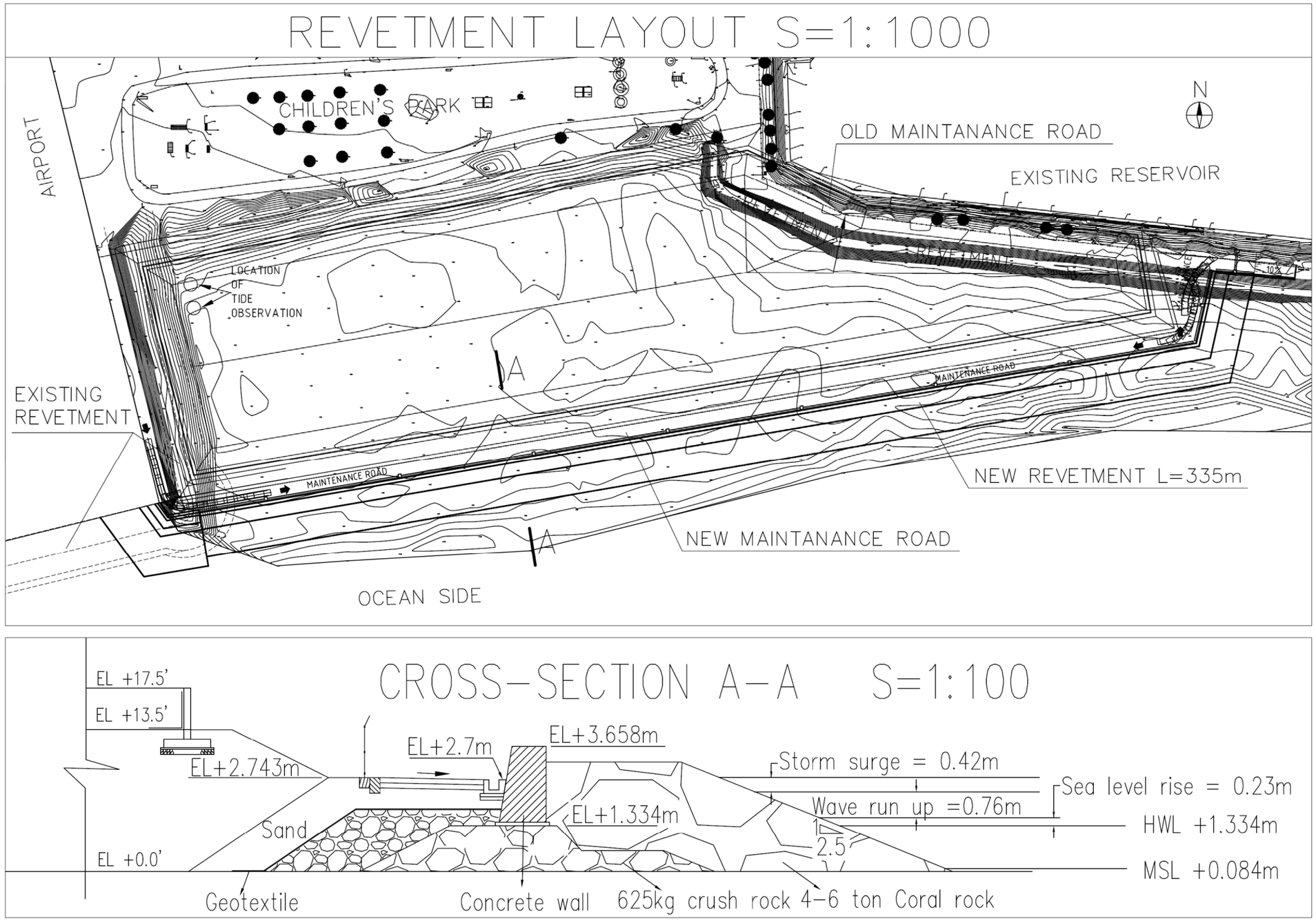
Table 2.2-15 A List of Outline Design Drawings

No.	Drawing No.	Facility	Drawing Title
1.	GE-1	Overall Plan	General Drawing of the whole Proposed Facilities
2.	RE-1	Revetment	Plan and Cross Section of Revetments
3.	RR-1	Rainwater Reservoir	Plan & Cross Section of Rainwater Reservoir
4.	TP-1	Pipelines	Plan of Pipelines
5.	TP-2	Conceptual Flow	System Flow Diagram

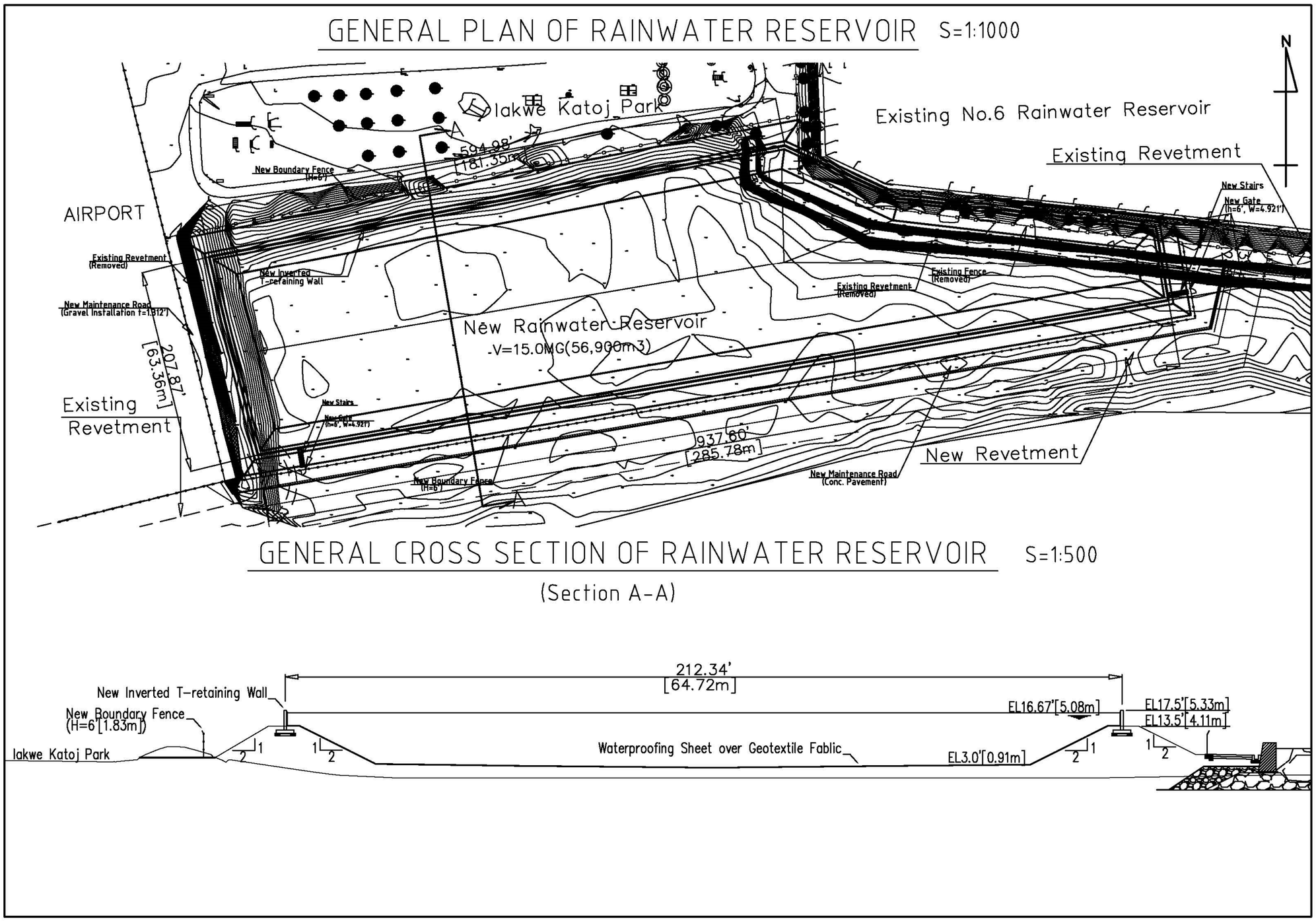
Source: JICA Survey Team



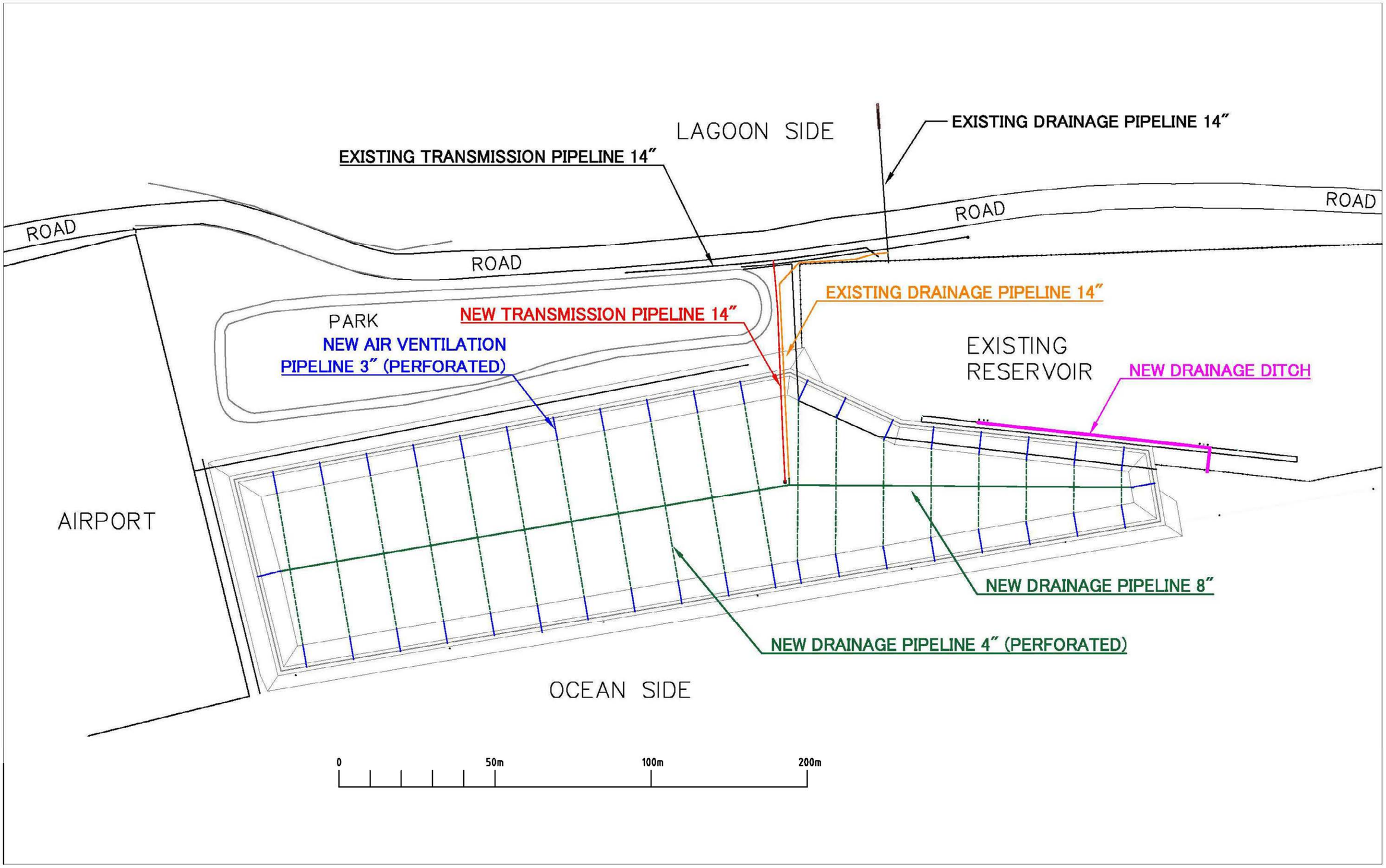
GE-1 General Drawing of the whole Proposed Facilities



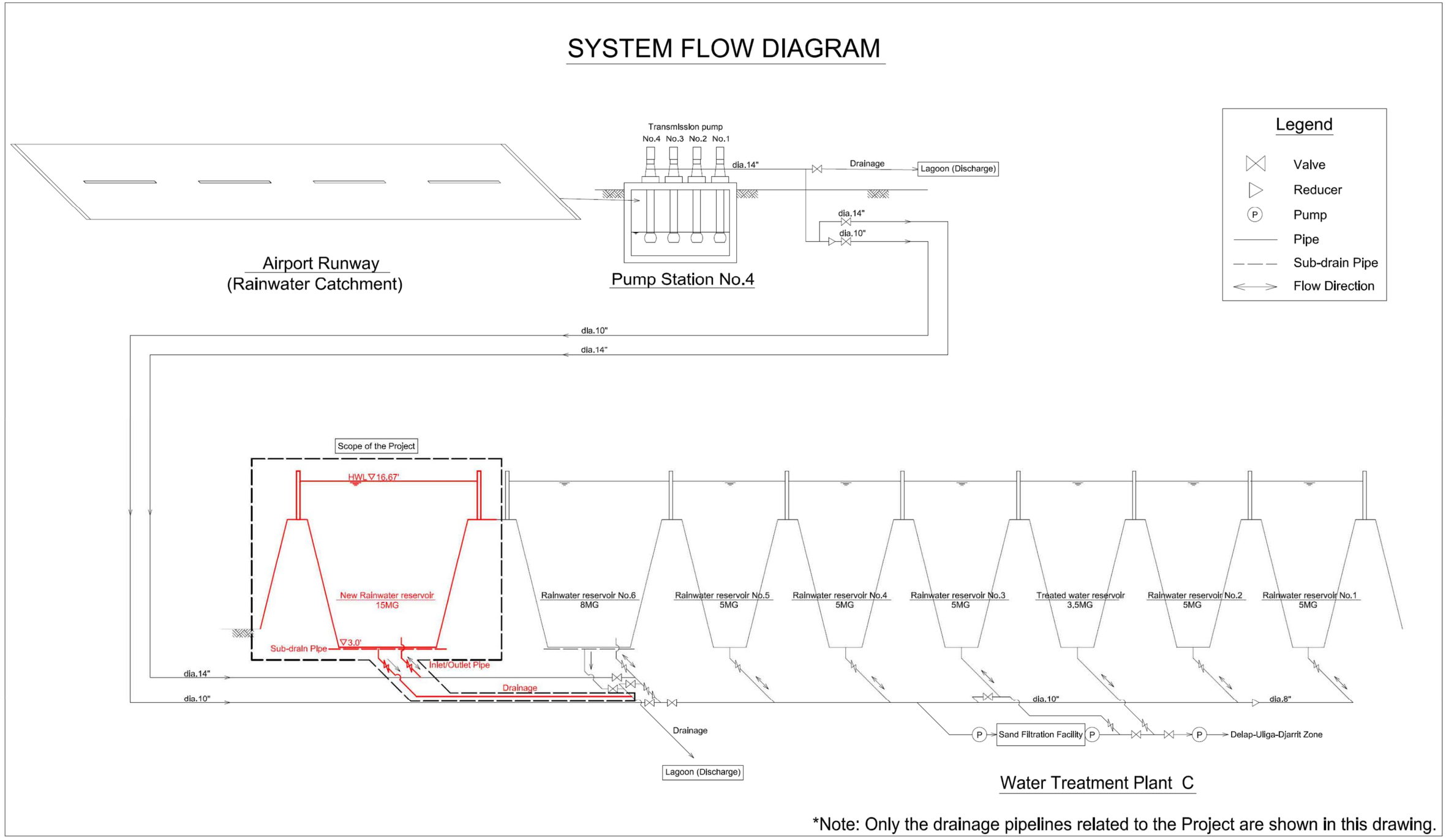
RE-1 Plan and Cross Section of Revetments



PR-1 Plan & Cross Section of Rainwater Reservoir



TP-1 Plan of Pipelines



TP-2 System Flow Diagram

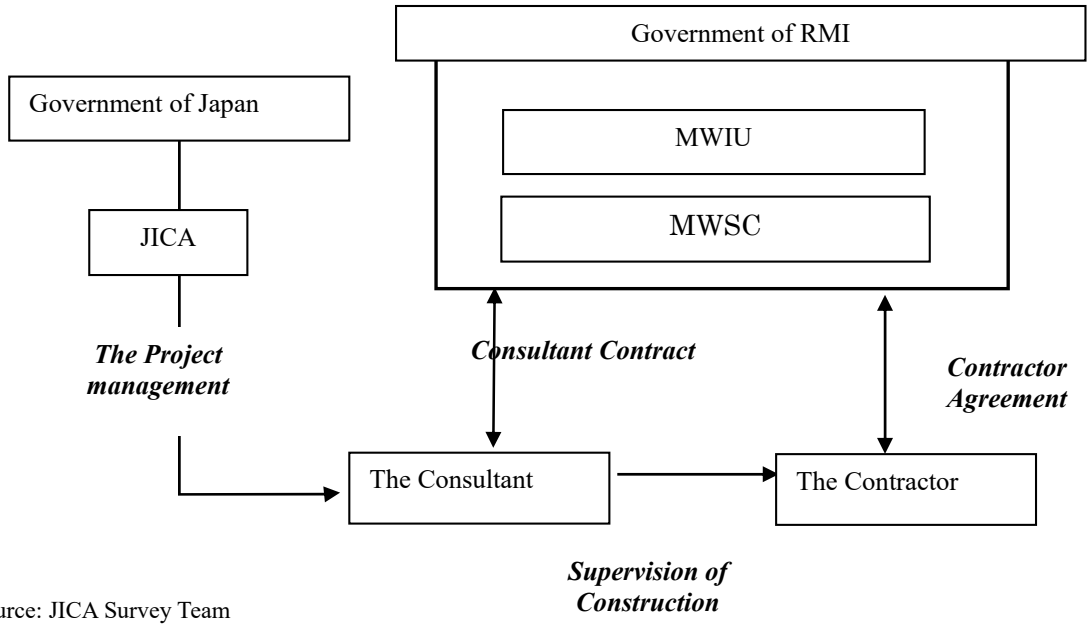
2-2-4 Implementation Plan (Construction/Procurement Plans)

2-2-4-1 Implementation Policy

(1) Implementation Structure

The Project will be implemented according to the framework of Japan's Grant Aid shown in Figure 2.2-29.

The Contractor will request local contractors to provide workers, supply construction vehicles, procure materials, provide quarry sites, and process customs clearance and tax exemption.



Source: JICA Survey Team

Figure 2.2-29 Implementation Structure

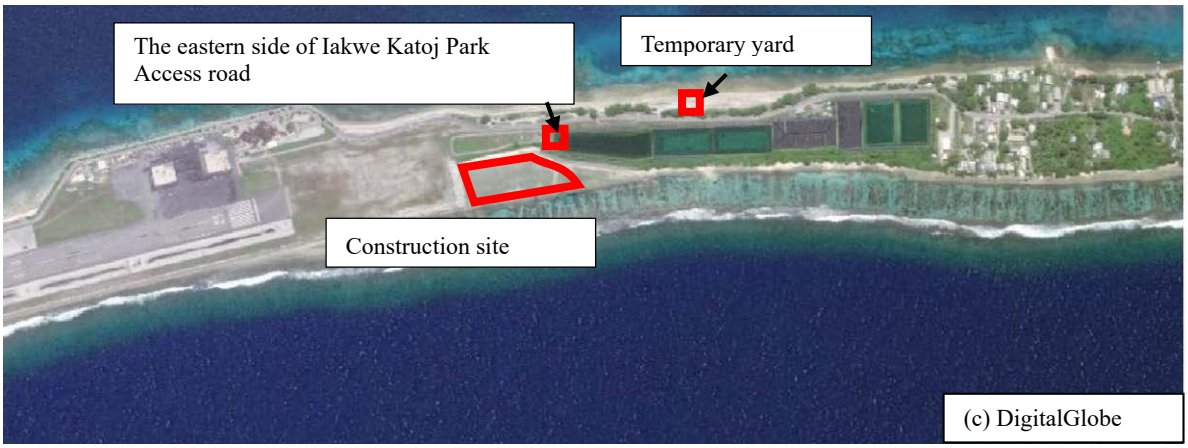
(2) Construction Method

Construction will be carried out based on the following methods.

1) Temporary yard and access road

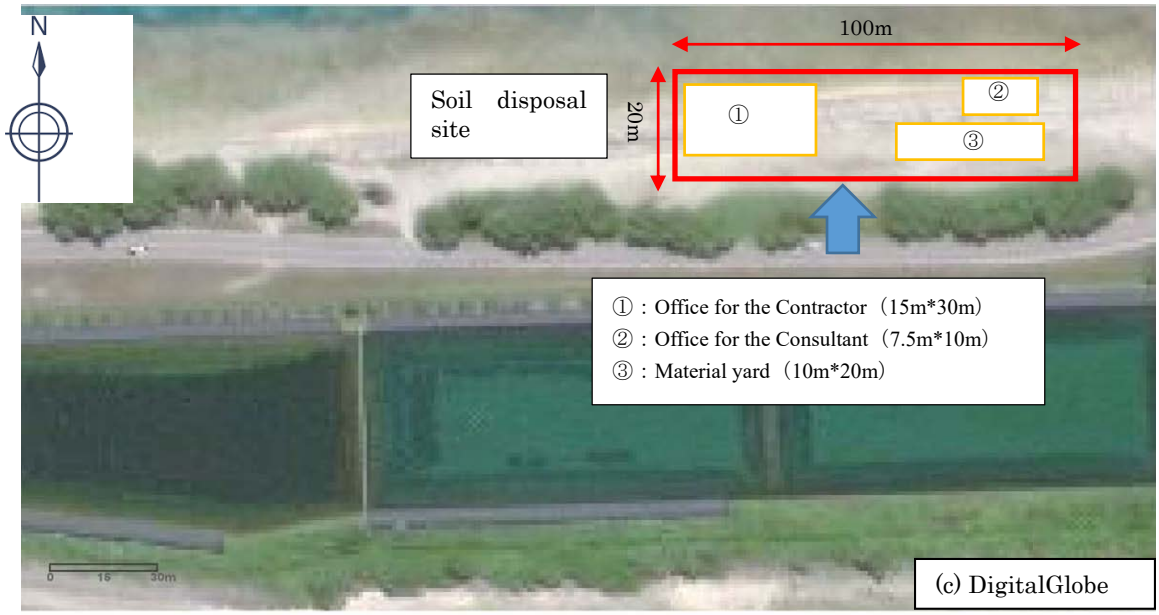
As shown in Figure 2.2-30 and Figure 2.2-31, MWSC will secure temporary yards (for stocking material, building offices for the Contractor and the Consultant, disposing soil, etc.) in the area under the management of the Government of RMI.

In addition, the eastern side of the park (Iakwe Katoj Park) will be utilized as an access road during construction.



Source：JICA Survey Team

Figure 2.2-30 Temporary Yard and Access Road

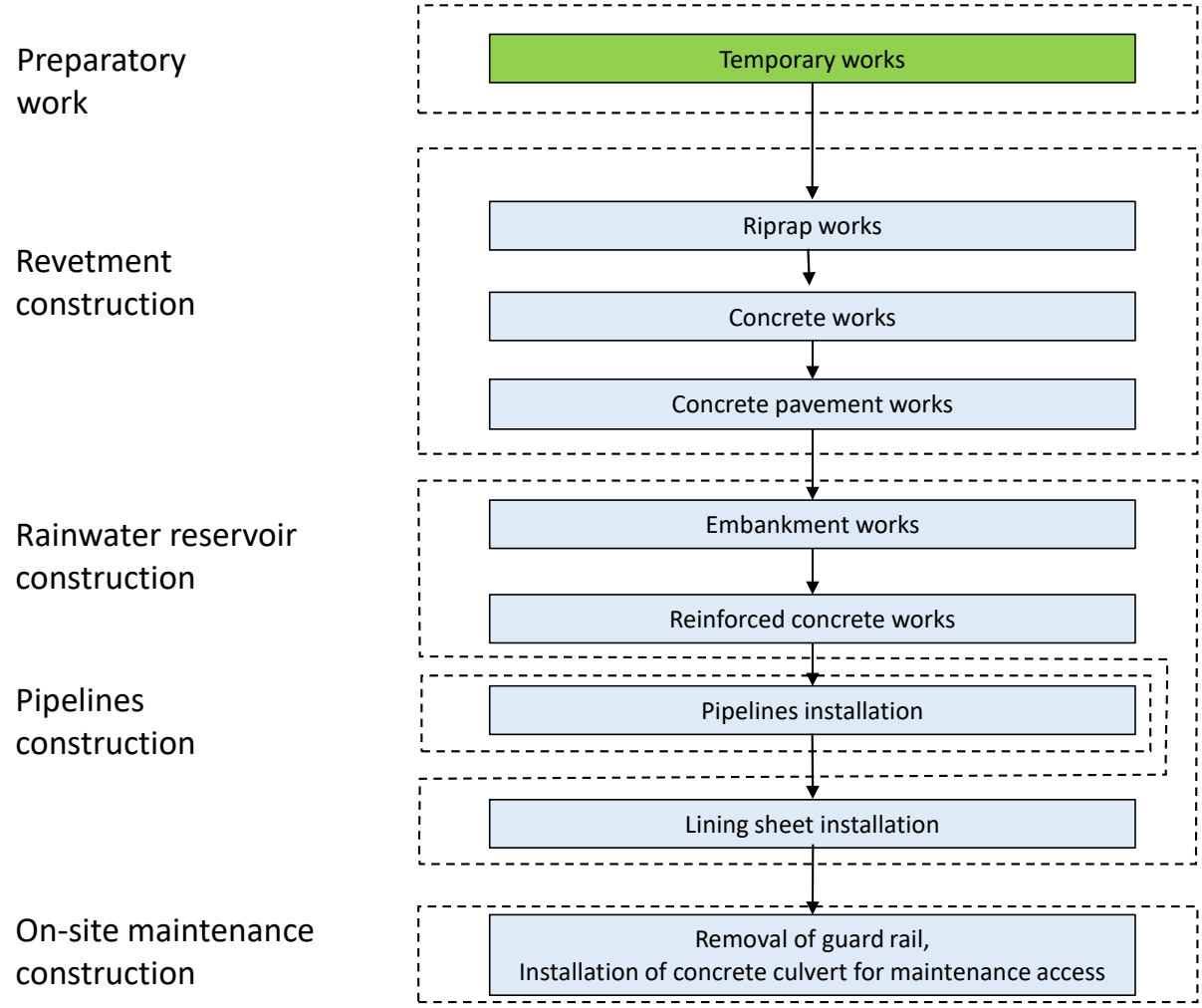


Source: JICA Survey Team

Figure 2.2-31 Details of Temporary Yard

(3) Construction Flow

Figure 2.2-32 shows the construction flow by Japanese side.



Source: JICA Survey Team

Figure 2.2-32 Work Flow

Revetment Construction Steps:

a) Construct the access stage with large sandbags and steel plates, and fill rocks with rough terrain cranes at the sites under HWL.
b) Place crushed stones behind the proposed revetment.
c) Purchase ready-mixed concrete and place it by using rough terrain cranes; in addition, work in night shift to prevent cold joint.

The mix ratio of ready-mixed concrete will be decided based on test results. Table 2.2-16 shows an example of a standard mix ratio of ready-mixed concrete based on interviews with local contractors.

Table 2.2-16 Concrete Composition

MPa		18	21	24	28
Cement	kg	220	260	290	330
Water	liters	103	112	110	112
Fine aggregate	kg	843	790	762	745
Coarse aggregate	kg	664	720	785	810
Admixture	litters	18	18	20	20

Source: interview of local contractors

Rainwater Reservoir Construction Steps:

a) Place concrete to the rainwater reservoir and the revetment at night.
b) Line the rainwater reservoir with "lining sheet".

Pipe Installation Steps:

a) Excavate trench and temporarily place the excavated soil by an excavator with a capacity of 0.28 m^3, and install the pipes.
b) Backfill the trench first with sand and then the select material by the excavator and compact it with a tamper and vibrating roller.

2-2-4-2 Implementation Conditions

(1) Construction Materials

Construction materials such as concrete, rock, and aggregate will be basically procured locally, but other materials, such as rebar and pipe materials, which are not locally available, will be procured from Japan and/or third countries (see Table 2.2-17).

Table 2.2-17 Major Materials by Procurement Country

Items	Japan	Republic of the Marshall Islands	Third Country	Remarks
Ready-mixed concrete		X		Ready-mixed concrete will be procured locally. Cement ASTM C150 Type I is popular in RMI.
Epoxy coated rebar	X		X	Rebar is not available in the local markets, so it will be procured from Japan or third countries. A contractor will bend and cut the rebar in situ and repaint it.
Plywood for formwork		X		Plywood for formwork will be procured locally. However, separators are not available in the local market. Therefore, Separators will be procured from Japan or third countries. The Contractor will need to cope with saline damage
PVC			X	PVC is not available in the local markets, so it will be procured from Japan or third countries. The Contractor should procure the PVC complying AWWA standard.
Riprap		X		The quarry site permitted by RMIEPA (see Figure 2.2-33) will be used to quarry rock.
Embankment soil		X		Embankment soil will be hauled from the site permitted by RMIEPA (see Figure 2.2-33). The Contractor should procure embankment soil, which can be compacted easily, and is stable against changes of seepage and dry in embankment soil.
Lining sheet	X		X	Lining sheet is not available in the local markets, so it will be procured from Japan or third countries.
Construction		X		Major construction vehicles such as

Items	Japan	Republic of the Marshall Islands	Third Country	Remarks
vehicles				excavators, dump trucks, and tire rollers will be procured locally.

Source: JICA Survey Team based on MWIU, MWSC, and local contractor

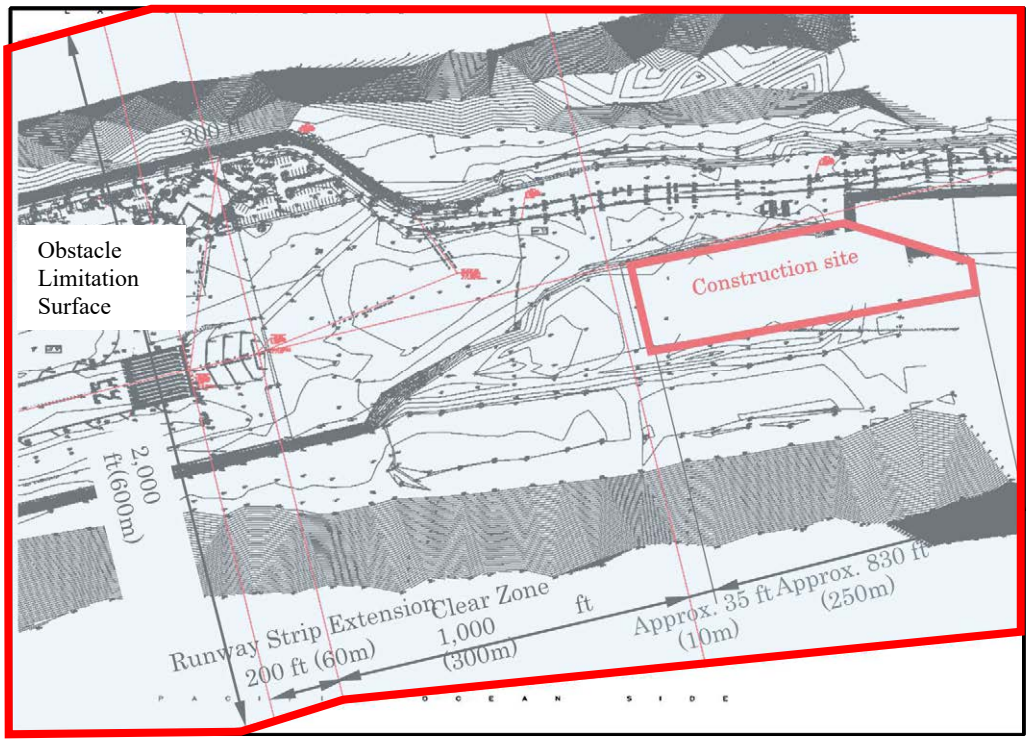
Figure 2.2-33 shows sand and rock quarry sites.

Figure 2.2-33 Sand and Rock Quarry Sites

Source: JICA Survey Team

(2) Obstacle Limitation Surface

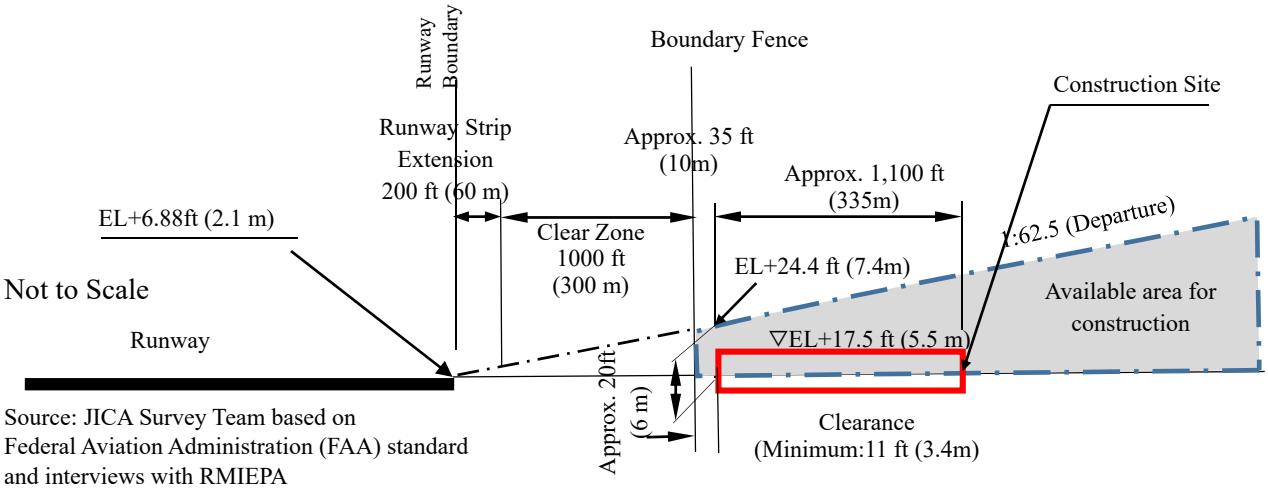
The construction site is adjacent to the runway of Majuro International Airport. In order to ensure the safe operation of incoming/outbound flights, the Team surveyed the obstacle limitation surface of Majuro International Airport through interviews with RMIPA. The result of the survey is shown in Figure 2.2-34 and Figure 2.2-35. The thick red line in Figure 2.2-34 shows the planar area of obstacle limitation surface, and the construction site is located within this area. As shown in Figure 2.2-35, the elevation of the of the eastern boundary surface of Majuro International Airport is EL + 24.4 ft (7.4 m), and it is higher than the crest level of the rainwater reservoir (EL + 17.5 ft (5.5 m)).



Not to scale

Source: JICA Survey Team based on interviews with RMIEPA

Figure 2.2-34 Approach Surface (Plan)



Source: JICA Survey Team based on Federal Aviation Administration (FAA) standard and interviews with RMIEPA
Note: 1:50 for approach surface for arrival

Figure 2.2-35 Approach Surface（Cross section）

The Team, MWIU, and MWSC agreed that MWSC will submit the "FAA Form 7460-1, Notice of Proposed Construction or Alteration" to RMIPA.

In addition, the use of construction vehicles such as trucks and cranes may occupy the approach surface. In such cases, according to the Civil Aviation Authority, which is responsible for the management of civil aviation under RMIPA, the Contractor needs to retract the boom of the construction vehicles to a level below that of the obstacle limitation surface starting from one hour before the arrival until one hour after the departure of the plane. The Contractor can carry out the construction at all other times.

2-2-4-3 Scope of Works

Table 2.2-18 shows demarcation of the scope of the work between the Japanese and RMI sides.

Table 2.2-18 Division of Work between the Japanese and RMI Sides

Items	Japanese side	RMI
1. Revetment		
- Land acquisition		x
- Revetment and road maintenance works	x	
2. Rainwater reservoir		
- Land acquisition		x
- Rainwater reservoir construction	x	
- Boundary fence and gate construction	x	
3. Pipelines		
- Pipeline works	x	
4. Securing the site for temporary works (stockyard, the Contractor / Consultant office, soil disposal site etc.)		x
5. Obtaining permissions from relevant government agencies for quarries and the pipelines installation		x
6. Tax exemption procedures		x
7. Transportation of equipment to be procured from abroad to the construction site	x	
8. Temporary road		
- Land acquisition		x
- Temporary road construction	x	

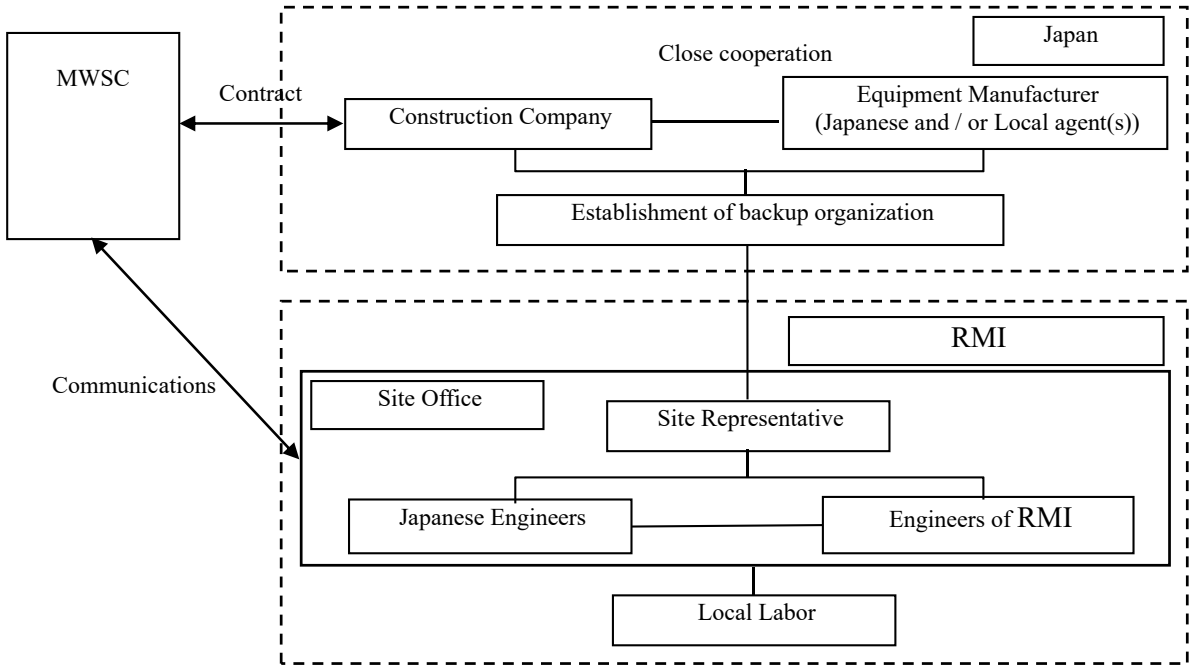
Note: "x" indicates responsible side.
Source: JICA Survey Team based on discussions with MWIU and MWSC

2-2-4-4 Construction and Procurement Supervision Plan

(1) Structure of Construction/Procurement Contractor

1) Implementation Structure of Contractor

The Project contractor will establish a structure enhancing the close cooperation among local construction companies and material manufacturers (Japanese and / or local agent(s)) in order to order and supply construction materials smoothly. The outline of the implementation structure of the Contractor is expected to be as shown in Figure 2.2-36.



Source: JICA Survey Team based on discussion with MWIU and MWSC

Figure 2.2-36 Implementation Structure of Contractor

2) Backup Structure in Japan

The Contractor must establish a backup structure in Japan to provide a comprehensive coordination of all aspects of the construction works including civil engineering work, manufacture, and installation of pipes, as well as to provide technical and financial support to the Site Office.

3) Site Office

The Contractor must establish a construction management office in RMI to execute all the works. Moreover, it has to establish a management structure ensuring consistent and smooth execution of works in the country. This construction management office executes the works, employs local expert engineers, skilled workers, operators, drivers, workers, materials and equipment suppliers, and so on in RMI,

It is possible to procure the workforce such as engineers and skilled workers and construction vehicles, in RMI. However, for the following reasons, process control, quality control, safety management, etc. should be conducted under the supervision of skilled Japanese engineers with sufficient experience in similar Japan's Grant Aid projects. If the number of local engineers and technicians is insufficient, engineers and technicians may be hired from third countries, such as Philippine and Vietnam.

- The Project is implemented within the framework of Japanese accounting system and Japan's Grant Aid System. Therefore, the construction progress should be controlled by engineers having full understanding of these systems.
- Construction skills and supervision methods should be transferred to RMI side. Therefore, the construction supervision of the Project should incorporate the work procedures, quality control methods, and safety management methods used in Japan

The Project needs the Japanese construction management staff shown in Table 2.2-19.

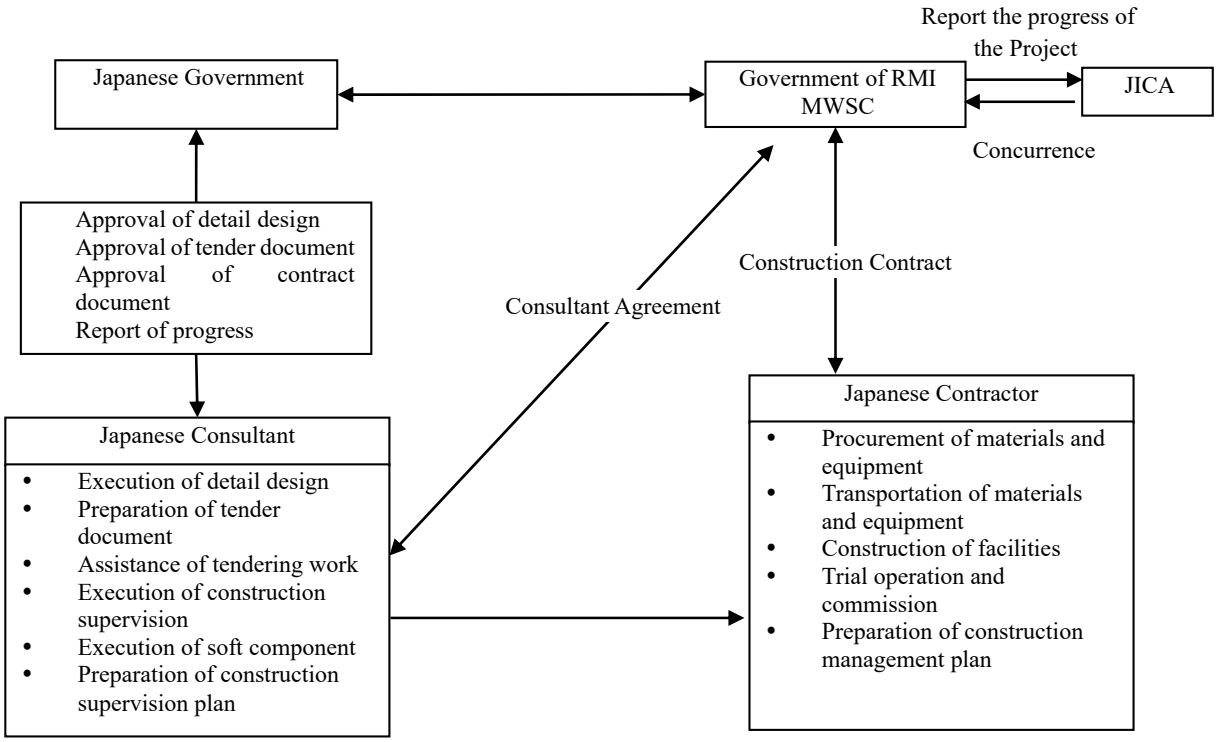
Table 2.2-19 Structure of Japanese Construction Management Staff

Position	Period	Number	Tasks
Resident supervisor (for civil work supervision)	Resident	1	● Manage the whole supervising work as a project leader ● Coordinate between RMI side and the Contractor on the whole supervising work ● Supervise the procurement, construction, schedule, quality and safety management of civil engineering work
Civil work supervisor/ Chief supervisor	Spot	1	● Supervise the procurement, construction, schedule, quality and safety management of civil work
Revetment work supervisor	Spot	1	● Supervise the procurement, construction, schedule, quality and safety management of revetment work
Clerk	Spot	1	● Paperwork, accounting, import/export support, purchase/transportation support

Source: JICA Survey Team

(2) Construction Supervision Structure

The Consultant will supervise and direct the Contractor to ensure the "completion of facility construction within the specified term of works", "quality of works specified in the contract documents", and "safe execution of the works". The role of the Consultant is to supervise construction works and independently confirm that it is implemented according to the Japan's Grant Aid scheme. The Consultant supervises the entire work of the Project under the structure shown in Figure 2.2-37.



Source: JICA Survey Team

Figure 2.2-37 Project Implementation Structure

Based on the Japan's Grant Aid system and considering the outline design, the Consultant establishes a project team that seamlessly performs detailed design and supervises the work for smooth implementation of the Project. At the construction supervision stage, the Consultant dispatches the following experts according to the work schedule to supervise process control, quality control, and safety management:

- Resident supervisor (for civil work supervision) : one person
- Revetment work supervisor : one person (spot)

- Pipe work supervisor/ Chief supervisor : one person (spot)

In addition, the Japanese supervisors participate in the inspection of the Project materials and equipment manufactured in or imported from Japan or third countries at the factory before their shipment, as necessary, to avoid troubles after their delivery.

The Consultant will supervise the work performance to ensure the completion of the works within the specified term of work, and supervise and direct the Contractor to ensure safe execution of works. In addition, the Consultant will employ local engineers and supervise the construction and procurement through the Japanese supervisors and the local engineers.

The following are the main points that require due attention in construction supervision.

1) Construction Schedule Control

The Consultant will confirm the work progress against the contract scheduled on monthly and weekly bases for each of the following items:

- The amount of work done
- The actual delivery and use of major materials and equipment
- The actual use of engineers, skilled workers, workers, etc.

If a delay is anticipated, the Consultant will analyze the reasons, and request the Contractor to submit corrective measures, and give directions to ensure the completion of the work within the scheduled period.

2) Safety Control

The Consultant will examine the appropriateness of safety control plan prepared by the Contractor and the actual implementation of the plan, and supervise the works in and around the Project sites to prevent labor accidents and accidents involving the third party during execution of works. Safety control will be executed using the following means:

- Confirmation of the safety control plan and appointment of a safety officer by the Contractor
- Confirmation of the adequacy of the formulated safety control plan and the appointed safety officer
- Confirmation of actual implementation of safety control plan
- Confirmation of the adequacy of the planned operation routes of construction vehicles, precautions taken in vehicle operation, and compliance to the plan

3) Construction Supervision in Japan

In Japan, the Consultant will establish the system necessary for the comprehensive supervision described below, and will perform overall supervision of the activities conducted in RMI and in Japan:

- Confirmation of contents of contracts including processes, progress, and product quality
- Examination of solutions to troubles on the site and directions to the Contractor
- Technical and financial support to the local office of the Consultant

2-2-4-5 Quality Control Plan

Based on the items listed below, the Consultant confirms whether the quality of facilities, materials and equipment satisfy the requirements described in the contract documents (technical specifications and implementation design documents).

If the product quality is considered unsatisfactory or failing to comply, the Consultant will alert the Contractor and shall request necessary amendment and corrective measures. Quality supervision will be performed in the following means:

- Reviewing and approving catalogs, specifications, and production drawings of materials and equipment
- Reviewing or witnessing test results/factory inspection results of materials and equipment
- Reviewing installation manuals; on-site test operation, adjustment, and inspection manuals; and execution drawings of materials and equipment

- Supervision of on-site installation works and witnessing trial operation, adjustment, and inspection
- Checking the Contractor's shop drawings
- On-site inspection of soil compaction by roller, bar arrangement, concrete strength, etc. during construction
- On-site confirmation of work performance and work methods
- Checking the actual work done against the Contractor's execution drawings
- Checking as-built drawings of facilities

The quality control plan in construction supervision is shown in Table 2.2-20.

Table 2.2-20 Quality Control Plan

Type of Work	Control Item	Inspection/Test Method	Standards
Pipe material	Dimension, strength and workmanship	Inspection report Visual inspection and measurement at factory	AWWA
Pipe installation	Position, elevation and leakage	Torque measurement Pressure test	AWWA
Concrete	Ready-mixed concrete	Slump, air & chloride test	Standard specifications for concrete structures by JSCE
	Concrete strength	Compressive strength test	ASTM
Reinforcement bar	Bar arrangement	Factory shipment record Bar arrangement measurement	Japanese Industrial Standards (JIS), JSCE ASTM
Structure workmanship	Dimension and workmanship	Visual inspection and dimension measurement	
Lining sheet	Strength Damage	Factory shipment record Visual inspection	Japan Lining Systems and Technologies Association
Revetment structure	Concrete	Same as that of the above concrete	
	Armor rock	Weight, slope	Construction Industry Research & Information Association (CIRIA) C683

Source: JICA Survey Team

2-2-4-6 Procurement Plan

Project materials and equipment will be in principle procured in RMI; but materials and equipment, which are not manufactured locally, will be procured from Japan or third countries.

(1) Construction Materials

It is possible to procure materials such as aggregates and formwork in RMI; but cement and rebar are not manufactured locally, so the Contractor will procure them from a third country.

Regarding the formworks, the Contractor will take necessary measures to protect steel materials, such as separators, from corrosion.

Furthermore, pipes (PVC and DIP) necessary for piping are not manufactured locally, so the Contractor will procure them from a third country.

The supplying countries of major construction materials are shown in Table 2.2-21.

Table 2.2-21 Materials by Procurement Country

Item	RMI	Japan	Third Country
1. Construction materials			
(1) Cement			x
(2) Ready-mixed concrete	x		
(3) Aggregate	x		
(4) Riprap	x		
(5) Reinforcement bar (ASTM standards)		x	x

Item	RMI	Japan	Third Country
(6) Formwork	x		
(7) Scaffolding / support materials	x		
2. Pipes			
(1) PVC pipes (AWWA standards)			x
(2) DI pipes (AWWA standards)			x
(3) Valves (AWWA standards)			x
6. Others			
(1) Gasoline and diesel oil	x		

Source: JICA Survey Team

(2) Construction Equipment

Construction equipment and transport vehicles are available in the local markets. Table 2.2-22 shows the procurement countries of major construction equipment.

Table 2.2-22 Major Construction Equipment by Procurement Country

Major equipment		Specification	Procurement country		
			RMI	Japan	Third country
1	Rough terrain crane	Hydraulic 45 t	x	—	—
2	Backhoe	0.80 m^3	x	—	—
3	Bulldozer	15t	x	—	—
4	Dump truck	10t, 20t	x	—	—
5	Road roller	10t–12t	x	—	—
6	Tire roller	8t–20t	x	—	—
7	Tamper	60–80kg	x	—	—

Source：JICA Survey Team

(3) Transportation of Materials and Equipment

Project materials and equipment such as rebar and piping materials, from Japan and third countries will be transported to Majuro International Port (Delap Dock) via sea (see Figure 2.2-38). The asphalt road in good condition from Majuro International Port to the construction site (Lagoon Road) can be used for large trucks.

Source: JICA Survey Team

Figure 2.2-38 Transportation Route

2-2-4-7 Operational Guidance Plan

The facilities constructed by the Project are the water transmission pipeline, rainwater reservoir and revetment. Because O&M of the proposed water transmission pipeline and storage facilities are basically as same as the existing system, it is not necessary to add particular O&M. However, the Contractor shall implement an initial guidance as an on-the-job training for the facilities to be constructed such as

operation of valves for inflow/outflow pipeline and discharge pipeline of the rainwater reservoir. The Consultant would conduct an initial O&M guidance for the entire reservoir system to MWSC.

2-2-4-8 Technical Assistance Plan

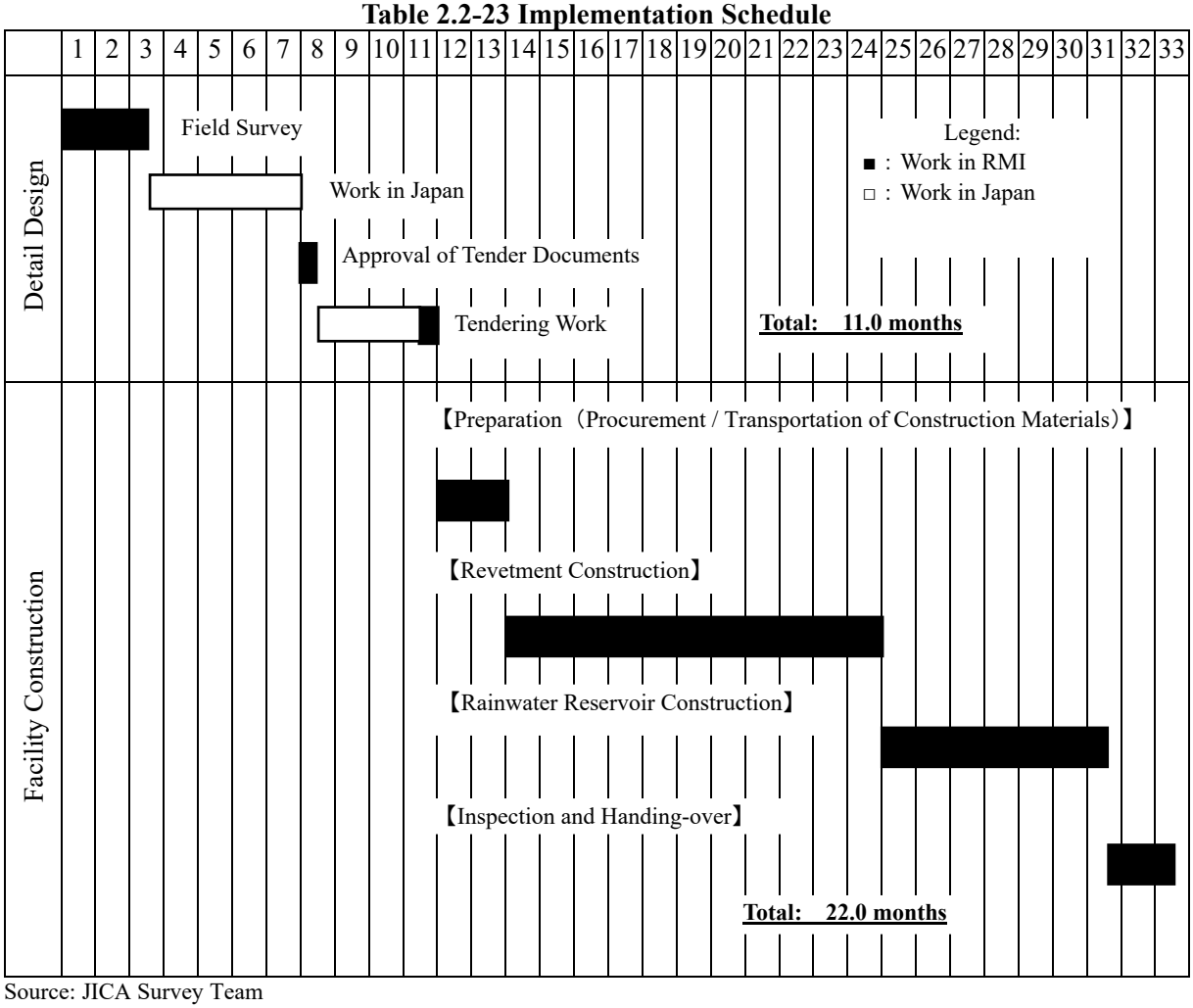
Operation of the rainwater reservoir to be constructed through the Project is based on that of the existing rainwater reservoirs. It was confirmed that structure of operation in MWSC would not change. Therefore, training of rainwater reservoir's operation will not be included in the Project.

2-2-4-9 Implementation Schedule

The construction of the Project facilities will start after the approval by the Japanese Government, and after the conclusion of Exchange of Notes (E/N) and Grant Aid Agreement (G/A) between Japan and RMI. The expected Project completion period is 33 months, including detailed design and tendering pre-approval of the Project by the Japanese Government. Therefore, a multi-year national bond system shall be applied for the Project.

Table 2.2-23 shows the implementation schedule of the Project.

Table 2.2-23 Implementation Schedule



Source: JICA Survey Team

2-3 Security Plan

According to MWSC and MWIU, only a few violent crimes, such as robbery and murder, are reported, and Majuro security condition seems relatively good. Actually, Marshall Islands 2019 Crime & Safety Report Overseas Security Advisory Council (OSAC) reported that the ratio of crime in RMI is low, but three persons were killed in the past two years.

The USA Embassy in RMI has not issued any particular warning of threats like terrorism recently in RMI.

Considering the global security risk, however, it is important to implement the Project carefully.

2-4 Obligation of Recipient Country

2-4-1 Main Undertakings by RMI

The Project is composed of Japanese assistance and the works to be undertaken by RMI. Table 2.4-1 shows the summary of works that RMI has to implement in three different stages: before the commencement of the Project, during the construction of the Project and after the completion of the Project.

Table 2.4-1 Undertakings by RMI

No	Items	Deadline	In charge
	Before the Bidding		
1	To sign the banking arrangement (B/A) with a bank in Japan (the Agent Bank) to open a bank account for the Grant	within 1 month after the signing of the G/A	MWSC and MOF
2	To issue an authorization to pay (A/P) to the Agent Bank for the payment to the consultant	within 1 month after the signing of the contract(s)	MWSC and MOF
3	To bear the following commissions to the Agent Bank for the banking services based upon B/A		MWSC
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	MWSC
	2) Payment commission for A/P	every payment	MWSC and MOF
4	To approve EIA (Conditions of approval should be fulfilled, if any) and secure the necessary budget of implementation for EMP and EMoP (and fulfilling conditions of approval, if any).	within 1 month after the signing of the G/A	MWSC and RMIEPA
5	To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report	until land acquisition and resettlement complete	MWSC and MWIU
6	To secure and clear as below		
6.1	To secure and clear the following lands		MWSC and MWIU
	1) Project site for water reservoir at Majuro	by September 2019	
	2) Temporary construction yard and stock yard near the Project area	before notice of the bidding documents	
	3) Temporary access road to the Project area	before notice of the bidding documents	
6.2	To secure the following lands		MWSC and MWIU
	1) Borrow pit and disposal site near the Project area	by September 2019	
6.3	Clarify the land issues		MWSC
7	To obtain the building permit	before notice of the bidding documents	RMIEPA, MWIU and MWSC
8	To submit Project Monitoring Report (First edition is shown in Appendix-6 and it will be updated based on the result of Detailed Design)	before preparation of the bidding documents	MWSC
	During the Project Implementation		
1	To issue A/P to the Agent Bank for the payment to the contractor	within 1 month after the signing of the contract(s)	MWSC and MOF
2	To bear the following commissions to the Agent Bank for the banking services based upon the B/A		
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	MWSC

No	Items	Deadline	In charge
	2) Payment commission for A/P	every payment	MWSC and MOF
3	To ensure prompt unloading and customs clearance at ports of disembarkation in the RMI and to assist the Supplier(s) with internal transportation therein	during the Project	MWSC
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 RMI and stay therein for the performance of their work	during the Project	Ministry of Justice, Immigration and Labor supported by MWSC
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the RMI with respect to the purchase of the goods and the services be exempted	during the Project	MWSC and MOF
6	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	MWSC and MWIU
7	To notify JICA promptly of any incident or accident, which has, or is likely to have, a significant adverse effect on the environment, the affected communities, the public or workers	during the construction	MWSC
8	1) To submit Project Monitoring Report	every month	MWSC
	2) To submit Project Monitoring Report (final) (including as-built drawings, equipment list, photographs, etc.)	within one month after issuance of Certificate of Completion for the works under the contract(s)	MWSC
9	To submit a report concerning completion of the Project	within 6 months after completion of the Project	MWSC
10	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the site(s)		
	1) Electricity The distributing line to the site	before start of the construction	MWSC and MWIU
	2) Water Supply The city water distribution main to the site	before start of the construction	MWSC and MWIU
	3) Drainage The city drainage main (for storm, sewer and others) to the site	before start of the construction	MWSC and MWIU
11	To take measure necessary for security and safety of the Project	during the construction	MWSC, MWIU
	- maintaining the safety of workers and the general public by thorough implementation of safety measures and immediate action in the case of accident		
	- traffic control around the site(s) and on transportation routes of construction materials		Contractor should provide traffic control with MWSC/MWIU coordination of services
12	To implement EMP and EMoP	during the construction	MWSC and RMIEPA
13	To submit results of environmental monitoring to JICA, by using the monitoring	during the construction	MWSC

No	Items	Deadline	In charge
	form, on a quarterly basis as a part of Project Monitoring Report		
	After the Project		
11	To take measure necessary for security and safety of the Project	during the construction	MWSC, MWIU
	- maintaining the safety of workers and the general public by thorough implementation of safety measures and immediate action in the case of accident		
	traffic control around the site(s) and on transportation routes of construction materials		Contractor should provide traffic control with MWSC/MWIU coordination of services
12	To implement EMP and EMoP	during the construction	MWSC and RMIEPA
13	To submit results of environmental monitoring to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report	during the construction	MWSC

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable)

2-4-2 Tax Exemption

The materials and services procured by the Project are in principle exempted from all types of taxes.

The Team confirmed that customs tax (import tax), sales tax, fuel tax, income tax and corporate tax are exempted for the Project.

There is no value added tax (VAT) in RMI.

The rates of the above taxes and the tax exemption procedures are explained below.

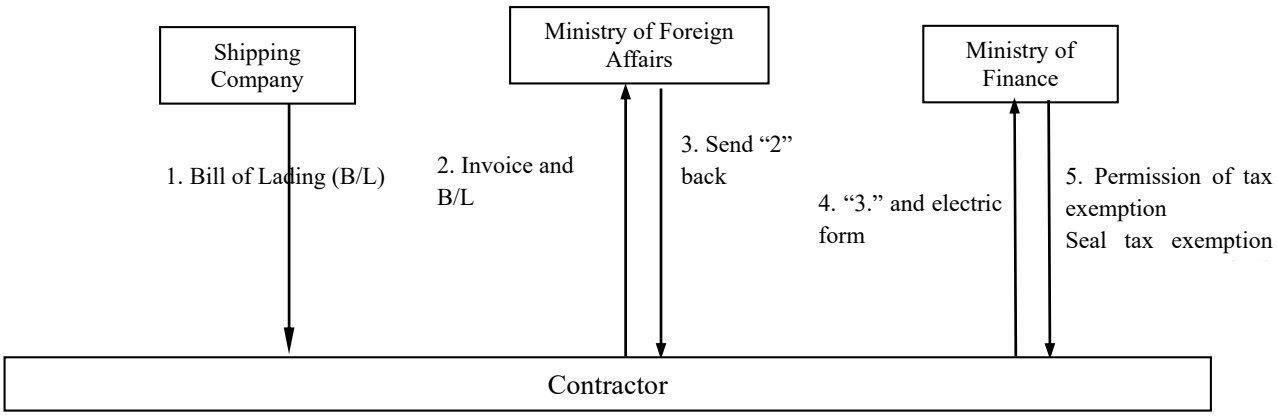
1) Customs duties (Import tax) by the customs office of the Ministry of Finance

A customs duty of 8% is levied on all goods, including grocery products, alcoholic beverages, and fuel.

The procedure of the tax exemption is shown in Figure 2.4-1.

According to Figure 2.4-1, the Contractor receives Bill of Lading (hereinafter referred to as “B/L”) from a shipping company, and submits it with an invoice of tax exemption to the Ministry of Foreign Affairs. The Ministry of Foreign Affairs sends the invoice and B/L back to the Contractor after appraisal. Afterward, the Contractor submits an electronic form, a letter and the B/L to the customs office of the Ministry of Finance.

The Ministry of Finance confirms the tax exemption by putting its seal of approval on the B/L.



Source: JICA Survey Team

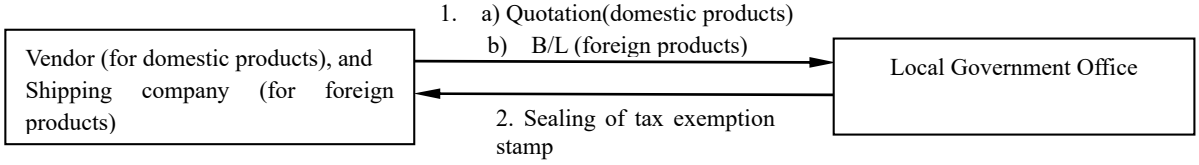
Figure 2.4-1 Customs Tax Exemption Procedure

2) Sales tax by the local government office

A sales tax of 4% is levied on all construction materials. The sales tax exemption procedure is shown in Figure 2.4-2.

Regarding domestic products, a contractor (including a sub-contractor) receives quotes from vendors, and submits them to the Local Government Office. Afterward, the office puts its seal of approval on the quote.

Regarding foreign products, a contractor (including a sub-contractor) receives B/L from a shipping company, and submits it to the Local Government Office. Afterword, the office puts its seal of the approval on the B/L.



Source: JICA Survey Team

Figure 2.4-2 Sales Tax Exemption Procedure

3) Fuel tax by Revenue of Taxation of the Ministry of Justice

Fuel taxes of 0.25 cents/gallon and 0.08 cents/gallon are levied on gasoline and diesel, respectively. The fuel tax exemption procedure is the same as that of the sales tax.

4) Income tax by Revenue of Taxation, the Ministry of Justice

Income taxes of 8% and 12% are levied on income less than USD10,400 and more than USD10,400, respectively.

Corporations that are registered in RMI are levied (If the annual income of a corporation is less than USD5,200, the corporations can get USD1,560 as refunds, by the tax return).

However, foreign corporations that are not registered in RMI are exempted from the income tax without any procedures

5) Corporate tax by the Ministry of Justice

Companies registered in RMI has to pay 3% of their profits as a corporate tax. However, foreign corporations that are not registered in RMI are exempted from the corporate tax without any procedures

2-4-3 Approximate Cost for Undertakings by RMI

Approximate cost for undertakings by RMI is shown in Table 2.4-2.

Table 2.4-2 Approximate Cost for undertakings by RMI

No.	Undertakings by RMI	Approximate Cost (USD)
1	Advising commission of A/P	464
2	Payment commission for A/P	46,800
3	To ensure prompt unloading and customs clearance at ports of disembarkation in the RMI and to assist the Supplier(s) with internal transportation therein	380
4	To provide facilities for distribution of electricity for the implementation of the Project outside the site(s) for the construction	3,500
5	To provide facilities for distribution of water supply for the implementation of the Project outside the site(s) for the construction	3,000
6	To provide facilities for drainage for the implementation of the Project outside the site(s)	4,000
	Total	**58,144**

Source: JICA Survey Team

2-5 Project Operation Plan

2-5-1 Revetments

As a manager of the revetment, MWIU should maintain the revetment in a good condition to serve its purpose of coastal protection. To achieve this, inspection works should be carried out to confirm the condition of every component, as well as hinterland protection function, and to perform improvement work if required.

Inspection is classified into initial inspection, patrol inspection, temporary inspection, and periodic inspection (primary inspection, secondary inspection).

2-5-1-1 Initial Inspection, Patrol Inspection, and Temporary Inspection

Purpose:

- Identify the revetment structures as well as all components that should be checked during inspection and improvement.
- Detect major changes that affect the protective function, the safety of the hinterland and users.
- Investigate the progress of deformation and damage detected during previous periodic inspections and confirm the existence of other changes.

Method: on-ground visual inspection
Implementation period:

- The inspection should be carried out about three times a year, taking into consideration the summer (when the coast is expected to be used) and high wave seasons.
- Temporary inspection should be conducted after the occurrence of storm surges or high waves.

Table 2.5-1 shows patrol and temporary inspection items.

Table 2.5-1 Patrol and Temporary Inspection Items

Location	Checking points
Parapet	Check if there is any crack that extending from one side to another side of the parapet (with a width of about 5 mm or more)
	Check if there is any large movement or damage of parapet, and the size if there are joint openings and movement if.
Crest covering (Maintenance road)	Check for cracks with a width of about 5 mm or more.
	Check if there is any subsidence or pothole that might cause water stagnation.

Source: Created based on Manual of Coastal Conservation Facility Maintenance

2-5-1-2 Periodic Inspection

Purpose: To understand the structure of revetment as well as all components that should be checked

during inspection.

Method: On-ground visual inspection, close-up visual inspection, simple measurement, and detailed investigation if necessary.

Implementation period:

- It should be conducted once every five years.
- The necessity of a secondary inspection is determined based on the result of the primary inspection.

Table 2.5-2 shows the periodic inspection items.

Table 2.5-2 Periodic Inspection Items

Location	Checking points
Crest level	Check if there is any change in the design top height
Parapet	Check if there is a crack
	Check if there is damage
	Check if there is a crack
	Check if there is a lack of joint material, gap/shift
	Check if there is an exposure of rebar
	Check if there is damage
	Check if there is subsidence
	Check if there is water leakage
	Check if there are too many weeds/plants
Drainage	Check if there is misalignment of joints, joint opening, change in elevation, or slip
Armor rock	Check if there is deformation/ scattering of armor rock
	Check if there is damage of armor rock
	Check if it is different between the crest level of armor rock and the crest level of parapet compare with that of the initial design.

Source: Created based on Manual of Coastal Conservation Facility Maintenance

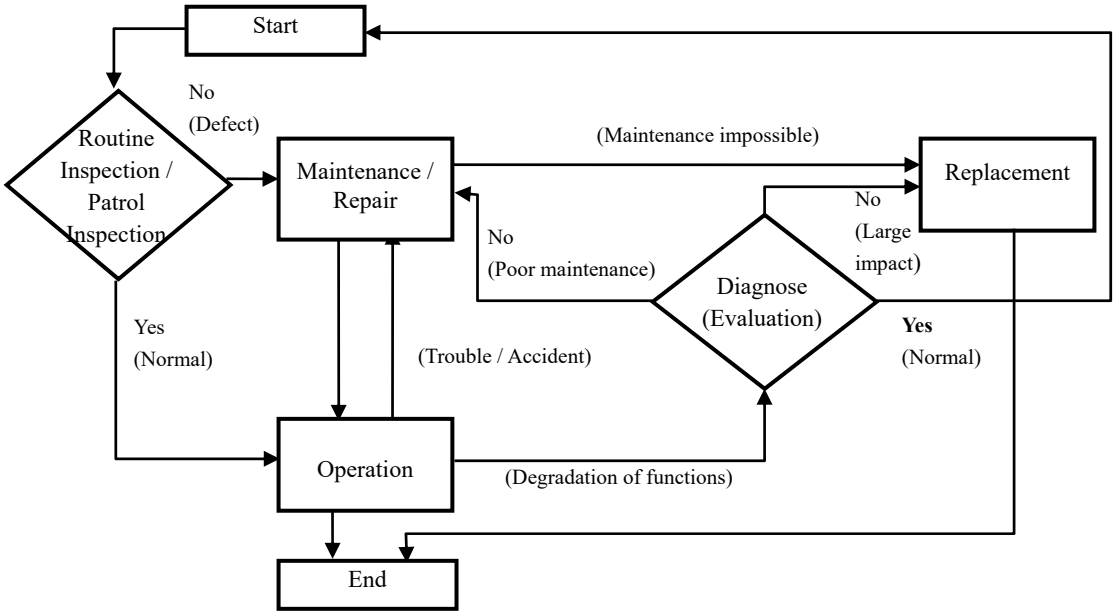
2-5-1-3 Maintenance Organization

As described in Section "2-2-1-6 (1)", "Response policy on operation and maintenance", the organization responsible for the operation and maintenance of the seawall is MWIU. MWIU also maintains the revetment facilities around the existing rainwater reservoir. The revetment facilities constructed in the Project are extension of the existing revetment and are close to each other, so they can be maintained in parallel. Therefore, MWIU does not need new departments or additional personnel, and the maintenance will be implemented under the current system.

2-5-2 Water Transmission and Storage Facilities

2-5-2-1 Basic Policy

For a long-term effective use of the facilities to be constructed under the Project and for stable and continuous water supply reflecting the fluctuation in daily demand, operation and management of facilities and protection of environment are indispensable. The RMI side should carry on suitable preventive maintenance which aims at keeping reliability, safety, efficiency, functions of facilities to secure the stable water supply. Figure 2.5-1 shows the basic policy for maintenance of the facilities in the Project.



Source: Guideline for Maintenance of Water Supply Facilities in Japan

Figure 2.5-1 Maintenance Flow of Water Supply Facilities

The Contractor will give technical guidance to MWSC on O&M of each equipment installed in the contract period. The Consultant does not need to conduct a technical support (soft component) because O&M of the water transmission and storage facilities of the Project are the same as those of the existing system. It is possible for the WTP-C Section, Operation Department, MWSC to operate the planned rainwater reservoirs.

2-5-2-2 Items for Periodic Inspection

Table 2.5-3 shows the main items that MWSC should focus on in operation and maintenance of the water transmission and storage facilities:

Operational management: Conducting operation and monitoring of equipment under normal conditions

Maintenance: Conducting maintenance, repair and preparation so that facilities and equipment can operate with their full capability

Table 2.5-3 Main Items of O&M for Facilities to be constructed in the Project

Classification	Main Items
Operational Management	1) Water Volume Control: Controlling equipment and devices conforming to the target water volume of rainwater reservoir
Maintenance	1) Inspection Item: 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. 2) Prevention: 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. Accumulation of sand at the bottom of the rainwater reservoir would be discharged by a submergible pump once per ten years. Accumulation of sand at the bottom of the pump well in the existing pumping station No. 4 would be discharged periodically to minimize the inflow of the sand to the rainwater reservoirs.

Source: JICA Survey Team

2-5-2-3 Spare Parts Purchase Plan

Spare parts will not be purchased for the Project.

2-5-2-4 Structure for Operation and Maintenance

Regarding the organization, the WTP-C Section of the Operation Department of MWSC is in charge of O&M of the Project. The staff of the WTP-C Section will also be in charge of the facilities to be constructed.

As described in Section "2-2-1-6", operation & maintenance for the water transmission and storage facilities to be constructed by the Project is the same as that of the existing facilities. Therefore, the WTP-C Section of the Operation Department will conduct the O&M of the facilities constructed by the Project in parallel with the existing facilities, and MWSC does not need to add any new organization and/or staff.

2-6 Project Cost Estimate

2-6-1 Initial Cost Estimate

This page is closed due to the confidentiality.

(1) Cost borne by Japanese side

This page is closed due to the confidentiality.

(2) Cost covered by RMI side

The cost incurred for banking commission, installation of power cable and water supply to the construction site is estimated to be about JPY 7.0 million (USD58,144) (See Table 2.4-2).

(3) Condition of cost estimation

1) Date of Cost Estimation: 30 June 2019
2) Exchange Rate: Average rate of March, April, and May 2019,
   USD1 = JPY 111.95
3) Construction Period: 22 months
4) Others: The Project will be implemented in accordance with the regulation of the Japanese grant aid project.

2-6-2 Operation and Maintenance Cost

2-6-2-1 Revetments

MWIU has consistently maintained and managed the revetment facilities, and the revetment facilities to be developed in the Project are almost the same as the existing revetment and can be adequately handled by the current department. Therefore, there will be no additional management cost.

2-6-2-2 Water Transmission and Storage Facilities

MWSC does not need additional organizations and/or staff because current staff of the WTP- C Section of the Operation Department will conduct the O&M of the facilities to be constructed by the Project. Therefore, no additional cost for O&M is needed.

CHAPTER 3 PROJECT EVALUATION

CHAPTER 3 PROJECT EVALUATION

3-1 Preconditions

Before the implementation of the Project, RMI and landowners must agree on the renewal of the land lease contract completely. With regard to this precondition, RMI government such as MCIA, MOF, MWSC and the landowners for Katoji Weto and Nakan Weto, which are parts of the construction site of the Project, signed on the addendum to the master ground lease agreement on May 20, 2020.

In addition, the necessity of EIA was assessed by RMIEPA based on the result of PEA after MAWSC submitted the Earthmoving Permit Application (hereinafter referred to as "EPA") to RMIEPA. Based on the result of PEA, RMIEPA concluded on the March 18, 2020 that there is no need for an EIA and will waive the need for an EIA for the Project.

3-2 Necessary Inputs by RMI

RMI must carry out the following tasks to achieve the expected outputs of the Project:

(1) Maintain and use the facilities to be constructed in the Project properly
(2) Appoint maintenance staff for the facilities to be constructed in the Project
(3) Conduct a monitoring plan and an environmental management plan as environment & social considerations
(4) Implement rehabilitation of the existing rainwater reservoirs smoothly so as to store raw water at the rainwater reservoirs appropriately

3-3 Important Assumptions

The expected outputs of the Project depend on the following important assumptions.

(1) Prevention of Leakage at the Existing Rainwater Reservoirs

The proposed rainwater reservoir aims at increasing the number water supply days in drought period. If, however, the leakage at the existing rainwater reservoirs increases, the expected output of the Project cannot be achieved. Therefore, MWSC must monitor the rainwater reservoirs daily, and take repair actions promptly when leakage is found.

(2) Reduction of Evaporation at the Proposed Rainwater Reservoirs

About 60 m^3 of water evaporates daily from the proposed rainwater reservoir. In order to reduce the evaporation rate, it is desirable that a floating-type photovoltaic power generation system will be installed in the future.

(3) Reduction of Leakage

Average NRW ratio has accounted for about 30% in the past five years. MWSC must take actions to reduce leakage, which makes up most of NRW, and protect the limited water resource available.

3-4 Project Evaluation

3-4-1 Relevance

(1) RMI's Policy

RMI's policy, which is related to the Project, is shown in Table 3.4-1. The policy includes strengthening the measures against climate change, and preparation for disasters caused by the climate change. National actions are required for ensuring potable water in drought period. The proposed rainwater reservoir is highly prioritized in the national policy as a measure against climate change.

Table 3.4-1 RMI's Policies and their Relevance to the Project

Policies	Relevance to the Project
Vision 2018 (2001)	● Improvement of Access to Safe Water
Agenda 2020 (2017)	● Strengthening water, energy and food security ● strengthening water security (expansion of rainwater reservoir in Majuro)
20-Year Water and Sanitation	● Planning construction (commencement in 2022) of new rainwater

Policies	Relevance to the Project
Strategic Plan (2017)	reservoirs with s total capacity of 46 MG (174,129 m^3): ➢ 16 MG (60,567 m^3) around Majuro International Airport ➢ 30 MG (113,562 m^3) around Peace Park
National Climate Change Policy Framework (2011)	● Preparing for protection of water resources against disaster
National Action Plan for Disaster Risk Management 2008-2018 (2007)	● Planning and securing access to safe water
Joint National Action Plan for Climate Change Adaptation and Disaster Risk Management (JNAP) (2013–18)	● Strengthening the resilience of the society across RMI ● Ensuring safe and enough water in drought period
National Water and Sanitation Policy (2014)	● Improving the resilience of infrastructure against climate change and abnormal weather

Source: JICA Survey Team

(2) Japanese Government Policies

The Japanese Government states the improvement of fundamental social services and assisting climate change measures as its basic policies for the bilateral cooperation with RMI. The Project is related to environment and climate changes, key sectors of the bilateral cooperation. In addition, the Japanese Government focuses on measures against water scarcity in drought period, and measures against high waves at high tide.

Moreover, Japanese Government focuses on strengthening the foundation for sustainable development in conformity with the declaration of the leaders at the Eighth Pacific Islands Leaders Meeting (PALM8) in May 2018, which adopted the cooperation on disaster prevention and climate change as one of its pillars.

(3) Relevance of the Project

The Project is to strengthen measures against and the preparation for climate change and related disasters in RMI by improving water security in drought period. The improvement of the water supply and measures against climate change are in line with the bilateral cooperation policy, and the Project can contribute to Goal 6 (Water Security: especially, Goal 6.1 "By 2030, achieve universal and equitable access to safe and affordable drinking water for all" and Goal 6.4 "By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity") and Goal 13 (Climate Change) of Sustainable Development Goals (SDGs). Accordingly, the Project is very important.

3-4-2 Effectiveness

As shown in Table 3.4-2, MWSC is facing issues in the following three aspects: (1) Management system; (2) Finance; (3) Facility development & maintenance.

Table 3.4-2 Water Supply Service Issues of MWSC

Items	Water Supply Service Issues
1) Management system	● Decrease of service connections ● Arrears of water bills
2) Finance	● Deficit
3) Facility development & maintenance	● Serious water rationing ● Insufficient measures against drought ● Leakage at the rainwater reservoirs ● Deterioration of pipe networks

Source: JICA Survey Team prepared based on an interview survey with MWSC.

Out of the above issues, the Team summarized the key problems and their countermeasures in Table 3.4-3 focusing on the capacity of water sources and other water supply facilities related to the requested Project.

Table 3.4-3 Water Supply Service Issues and Countermeasures

Issues	Countermeasures in the Project
Water rationing: ● Four hours daily ● Three days weekly	Construction of rainwater reservoir
Drought: ● Insufficient measures against four months in maximum	Construction of rainwater reservoir

Source: JICA Survey Team

The main components of the Project inputs and their expected effects are shown in Table 3.4-4.

Table 3.4-4 Effects Expected from the Main Components of the Project

Main Components	Effects to be expected	
Construction of Rainwater Reservoir	Direct Effect	● Increase of daily operation hours and weekly operation days (Quantitatively) ● Extension of water supply periods during drought (Quantitatively) ● Contribution to strengthening water security perception (Qualitatively)
	Indirect Effects	● Building-up a trustful relationship by extending the operation hours in ordinary and drought periods

Source: JICA Survey Team

The effectiveness of the Project is summarized below.

(1) Quantitative Effects

Table 3.4-5 shows water supply and demand. The rainwater reservoir with a capacity of about 15 MG (about 56,900 m^3) will be constructed newly, increasing the total storage capacity to about 51.5 MG (about 194,900 m^3). Consequently, the days to supply water to about 31,000 persons (assumed population as of 2026, three years after completion of the Project) will increase by 19 days. In other word, MWSC will be able to supply water for about 74 days continuously in the drought period, up from the current 55 days.

Table 3.4-5 Water Supply and Demand

Items	Calculation	Data	Remarks
Total water demand in Majuro in drought period (calculated based on assumed population (31,179 persons) of 2026)	(1)	947,902 GPD (3,588 m^3/day)	Water demand was calculated based on the following conditions and Table 3.4-6: ● Daily per-capita consumption: 20 gallon/capita/day (75.7 LCD) ● Institution and commercial water consumption: based on the Drought Management Plan 2015 ● Leakage ratio: based on the NRW ratio recorded in the past five years shown in the Capital Improvement Program Support ● Individual rainwater storage deducted: 1,500 gallons (5.7 m^3)

Items	Calculation	Data	Remarks
			● Monthly rainfall assumed/used to estimate the storage of the individual rainwater tank: one in.. ● Average individual roof area: 657 ft^2 (59 m^2) ● Ratio of rainwater collection on individual roof: 97.5 % based on Water and Sanitation Development Plan (July 2017)
Total water demand in Majuro in drought period (calculated based on assumed population (29,900 persons) of 2019)	(2)	914,991 GPD (3,463 m^3/day)	
Water to be supplied from Laura Treatment Plant	(3)	200,000 GPD (757 m^3/day)	Drought Management Plan, MWSC
Water to be supplied from Treatment Plant A	(4)	49,933 GPD (189 m^3/day)	Based on MWSC's data and Water Sanitation Development Plan (2017)
The demand after the supplies from Laura Treatment Plant and Treatment Plant A are deducted from the total water demand of 2026	(5) = (1) – (3) – (4)	697,969 GPD (2,642 m^3/day)	For reference: Water demand in 2050 is estimated at 821,391 GPD (3,109 m^3/day) based on the process as same as that for 2019 and 2026.
The demand after the supplies from Laura Treatment Plant and Treatment Plant A are deducted from the total water demand of 2019	(6) = (2) – (3) – (4)	665,058 GPD (2,517 m^3/day)	
Storage capacity of the existing rainwater reservoir to supply water to the WTP-C	(7)	36.5 MG (138,000 m^3)	MWSC
Storage capacity of the proposed rainwater reservoir to supply water to the WTP-C	(8)	15 MG (56,900 m^3)	JICA Survey Team
Total storage capacity of the rainwater reservoir to supply water to the WTP-C	(9) = (7) + (8)	51.5 MG (194,900 m^3)	Evaporation is not considered for this calculation, because storage volume increases with rainfall.
Total number of days that water can be supplied to the WTP- C continuously when there is no water inflow into the rainwater reservoirs as of 2026	(10) = (9) / (5)	74 days	For reference: Total number of days that water can be supplied to the WTP- C continuously in 2050 is estimated at 63 days through the same process as that for 2019 and 2026.
Total number of days that water can be supplied to the WTP- C continuously when there is no water inflow into the rainwater reservoirs as of 2019	(11) = (7) / (6)	55 days	

Source: JICA Survey Team

Table 3.4-6 which is a basis of Table 3.4-5 shows water demand calculated based on assumed population as of 2019 in Majuro. Water demand in Majuro is about 0.91 MGD (3,463 m^3/day) and about 0.95 MGD (3,588 m^3/day) in 2019 and 2026 respectively. Net water demand is estimated by deducting the rain water collected at individual house.

Table 3.4-6 Estimated Water Demand

Items	Calculation	2019	2026	Remarks
Population	1)	29,900	31,179	Assumed by JICA Survey Team based on statistical data For reference: 2050: 35,992 persons (assumed)
Number of Households	2) =1) / 6.7 person / household	4,463	4.654	Based on 6.7 persons / household
Daily per-capita-per-day (gallon)	3)	20	20	
Domestic (gallon/day)	4) =1) x 3)	598,000	623,580	
Ditto (m^3/day)		2,260	2,360	
Commercial (gallon/day)	5)	60,900	60,900	
Ditto (m^3/day)		230	230	
Institution (gallon/day)	6)	43,500	43,500	
Ditto (m^3/day)		160	160	
Total water Consumption (gallon/day)	7) = 4) + 5) + 6)	702,400	727,980	
Ditto (m^3/day)		2,650	2,750	
Volume of water that can be stored at an individual tank (gallon/day)	8) 226 m^3/day or 217 m^3/day x 1000/3.785 liter /gallon	57,332	59,709	See Table 3.4-7
Ditto (m^3/day)		217	226	
Total water consumption after deducting volume of water that can be stored at an individual tank (gallon/day)	9) =7) - 8)	645,068	668,271	
Ditto (m^3/day)		2,442	2,529	
Leakage Ratio* (%)	10)	29.5	29.5	
Leakage Water* (gallon/day)	11) = 12) – 9)	269,922	279,631	
Ditto (m^3/day)		1,022	1,058	
Water demand (gallon/day)	12) =9) / (100% - 10))	**914,991**	**947,902**	
Ditto (m^3/day)		**3,463**	**3,588**	

Source: JICA Survey Team prepared based on " MWSC Drought Management Plan 2015", "Capital Improvement Program Support Consultancy Service Phase 1 – Water Supply Summary Paper".
Note: * Since the data of quantity of leakage and leakage ratio is unknown, a ratio of leakage which makes up most of NRW was applied for the estimated water demand.

In addition, Table 3.4-7 shows roof area at individual houses and volume of water that can be collected on them in Majuro. This is a basis of water demand shown in Table 3.4-6. Average roof area per house is about 657 ft^2 (59 m^2) and monthly volume of water to be collected on roof of the 4,463 houses (2019) and 4,654 houses (2026) is 1.72 MG (6,521 m^3) and 1.80 MG (6,800 m^3) respectively.

Table 3.4-7 Average Roof Area and Collected Water on It

Roof Area Size	Calculation	Average Roof Area		Number of Household (as of 2011 by national census)
(ft^2)		(ft^2)	(m^2)	
Less than 100		50.0	4.5	871
100 – 299		199.5	18.0	797
300 – 499		399.5	36.0	799
500 – 999		749.5	67.5	968
1,000 – 1,999		1,499.5	135.0	467
2,000 – 4,999		3,499.5	315.0	138

Roof Area Size	Calculation		Average Roof Area		Number of Household (as of 2011 by national census)
(ft^2)			(ft^2)	(m^2)	
5,000 or greater			5,000.0	450.0	52
Average roof area per house (ft^2/m^2)	1)		657	59	
Total number of household	2)				Assumed number of households: 2026: 4,654 households 2019: 4,463 households For reference 2050: 5,372 households
Monthly rainfall (in.)	3)			1.0	
Monthly rainfall (mm)	4) = 3) x 25.4 mm/in.			25.40	
Monthly minimum collected water per household (m^3)	5) = 4) / 1000 x 1) x 97.5%			1.46	
Ditto (gallon)				386.03	
Monthly minimum collected water of all households (m^3)	6) = 5) x 2)	2026		6,800.12	
		2019		6,521.05	
Ditto (MG)		2026		1.80	
		2019		1.72	
Daily minimum collected water of all households (m^3)	7) = 6) / 30 days	2026		226.67	
		2019		217.37	
Ditto (MG)		2026		0.06	
		2019		0.06	

Source: JICA Survey Team prepared based on "Capital Improvement Program Support Consultancy Services Phase 1 - Water Supply Summary Paper".

The Project will mitigate the water supply issues that MWSC is currently facing. Therefore, the Project is expected to improve MWSC's water supply service.

Table 3.4-8 shows the baseline condition and the Project effect, quantitatively.

Table 3.4-8 Quantitative Effect of the Project

Indicator	Baseline (Assumed baseline year: 2019)	Goal (Three year after the Project is completed: 2026)
Total number days that water can be supplied to the WTP-C continuously in drought period	55 days	74 days

Source: JICA Survey Team

Moreover, the Team estimated water demand of 2050[11] through the same calculation process as that of water demand as of 2019 and 2026 as shown in Table 3.4-5 to Table 3.4-7. The water demand after the supplies from Laura Treatment Plant and Treatment Plant A are deducted from the total water demand of 2050 is estimated at 821,391 GPD (3,109 m^3/day). After completion of the Project, unless new rainwater reservoirs are developed, total number of days that water can be supplied to the WTP- C continuously in drought period will be shortened from 74 days as of 2026 to 63 days as of 2050.

(2) Qualitative Effects

- Improvement in quality of life and public hygiene through the improvement of water supply service, such as reduction of water rationing.
- Creating sound water circulation by reduction of intake from fresh lens layer during drought period.

[11] Conditions such as population growth rate, etc. for water demand prediction of 2050 is not precise. The same condition for water demand prediction of 2026 was simply applied for that of 2050.