TUVALU

DEPARTMENT OF FISHERIES

DEPARTMENT OF MARINE

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF FUNAFUTI PORT IN TUVALU

May 2007

Japan International Cooperation Agency

Fisheries Engineering Co., Ltd.

Preface

In response to a request from the Government of Tuvalu, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Funafuti Port in Tuvalu and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tuvalu a study team from November 16 to December 14, 2006.

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

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

I wish to express my sincere appreciation to the officials concerned of the Government of Tuvalu for their close cooperation extended to the teams.

May 2007

Masahumi Kuroki
Vice-President
Japan International Cooperation Agency

May 2007

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Improvement of Funafuti Port in Tuvalu.

This study was conducted by Fisheries Engineering Co., Ltd., under a contract to JICA, during the period from November, 2006 to May, 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tuvalu and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,

Toshiya Ogasawara
Project manager,
Basic design study team on
The Project for Improvement of Funafuti port in Tuvalu
Fisheries Engineering Co., Ltd.

Summary

Tuvalu is an island country situated between latitudes 5 and 11 degrees south and longitudes 176 and 180 degrees east in the South Pacific Ocean. It consists of nine coral reef islands dispersed over a wide area. The total population is 9,561, according to the 2002 census, 47% of which is concentrated in the capital Funafuti. 96% of the Tuvaluans are Polynesians. The national territory, which has neither mountains nor rivers, adds up to 23.96 km^2 in total, equivalent to Chichijima Island, which is located in the Ogasawara Islands. The country's exclusive economic zone (EEZ) covers 900,000 km^2. The country has a tropical climate with an average temperature throughout the year of between 29.0 to 29.5 degrees Celsius. The average precipitation in Funafuti is 3,515.8 mm per year (based on figures for 1945 to 2005), with the maximum rainfall concentrated November through to February.

The GDP per capita of Tuvalu was 2,478 Australian dollars as of 2002, according to the Asian Development Bank, making the country fall into the least developed country (LDC) category. The industrial breakdown of the GDP in 2002 was 13.3% for primary industry, 14.8% for secondary industry, and 71.9% for tertiary industry. As the national economy is moving toward self-sufficiency, the fisheries industry, which accounts for 6.4% of the entire GDP, is positioned as a key industry along with agriculture, represented by copra production, which has a GDP share of 5.6%. It is also considered as an extremely essential industry in terms of food security.

There are virtually no industrial commodities produced locally in Tuvalu. In 2005, the total value of imports was about 16.91 million Australian dollars, whereas the value of exports was 0.08 million Australian dollars. The population relies heavily on imports in terms of foodstuff and other daily necessities, and as a result, the purchase of imported goods occupied, on a simple-calculation basis, 77% of total household expenditures as of 2005. All these imported goods come through Funafuti Port; however, since the cargo-handling efficiency has deteriorated and containerships need to stay at the port for a long time, the transportation costs have been increasing.

In Tuvalu, where the overall soil condition is poor, fishery is the only industry that can sustainably develop. At least 76% of the households are engaged in fishing, with the figures being highest in the outer islands. A certain percentage of the marine products caught in these outer islands are transported to Funafuti, which brings valuable cash to the outer islands where 26% of the households live below the poverty line. The transportation of marine products from the outer islands to Funafuti is undertaken by three vessels: Nivaga II, Manu Folau and Manaui, and therefore the government of Tuvalu promotes the stable operation of these vessels.

Fishery is an important industry in Tuvalu in that the fishing license fee contributes about 10% of the national revenue and approximately 67% of the population is involved in the industry as a means of procuring

food or earning a wage. Further, the marine transportation industry is another key industry, supporting the foundation of the livelihood of the people, by transporting people and goods among the islands. With these things in mind, the government of Tuvalu has posted sustainable and effective use of marine resources, promotion of the outer islands through fisheries, and securement of stable inter-island transportation as priority issues in the fisheries and maritime transport sectors in its national development strategy, "VISION 2015 (1998-2015)".

The Tuvaluan Government has strived for a stable supply of marine products and the development of the regional economy in the country by establishing a Community Fisheries Center (CFC) in every outer island, except Niulakita Island, which has a population of only 35. Of the marine products unloaded at the CFCs, 29.8 tons of fresh/frozen products and 6.1 tons of salted dry fish were delivered to Funafuti in 2004, consequently bringing approximately 130,000 Australian dollars to the islands, which is equal to 11% of overall household income. In these outer islands where there are no other outstanding industries, the fishery industry plays a vital part in the local economies .

On the other hand, in congested Funafuti, the fish catch in the vicinity of the island cannot satisfy the annual demand for fish of approximately 270 tons. The shortfall of 100 tons per year is taken up by fish transported from the outer islands. In addition to supply by the CFCs and private companies, the provision of fish by the outer islands supplements the lack of fish in the capital. Therefore, if the distribution channel is disrupted, it will result in not only the loss of an opportunity for cash income for the outer islanders but also in disarray of the supply-demand balance in Funafuti. As a result, over-exploitation may occur in Funafuti's surrounding waters triggered by serious fish shortages, likely leading to a decrease in the resources and a hike in prices. Thus, the establishment of inter-island distribution routes for fishery products is one of the priority issues for the country.

In Tuvalu, where there are no domestic flights, marine transportation is the lifeline that supports virtually the entire population of the nation. The two inter-island vessels operated by the government not only transport daily necessities to the outer islands but also bring fish back to Funafuti. The inter-island vessels, therefore, play an important role in transporting people and daily commodities among the islands and are vital for the promotion of industries in the outer islands, such as fishery,as well as to help maintain people's day-to-day lives.

In 2006, Funafuti Port was used by 10,223 passengers ,handled approximately 6,073m^3 of domestic cargo, 536 import containers, and about 4,405m^3 of international bulk cargo. However, the cargo-handling activities at the port are exposed to various obstacles, including the restriction of the allowable cargo weight per container to 18 tons and a lack of port cargo-handling equipment. These inconveniences have resulted from the fact that the deepwater wharf is significantly superannuated after 27 years of use and is now at the risk of collapsing at any time owing to crumbling concrete, exposure of steel frames, the occurrence of cracks, etc.

Furthermore, there is not sufficient leeway for vehicles to travel in the container yard, forcing some cargo-handling work to be conducted using public roads as detours, thus sacrificing efficiency. Moreover, as the jetty is not long enough, containerships and Nivaga II have to use mooring lines when approaching and mooring at the jetty, hindering the access of other vessels to the port. That being the case, it is of great importance to improve Funafuti Port, including the construction of a replacement jetty.

In order to eliminate the difficulty in maintaining the port functions of the existing jetty due to aging and the shortage of cargo-handling equipment as well as various other current problems, the government of Tuvalu formulated the Project for Improvement of Funafuti Port, aiming at the improvement of Funafuti Port so as to maintain the safe and smooth landing of goods, and requested the government of Japan for grant-aid assistance in June 2005.

In response to this request, the Japanese Government decided to conduct a Basic Design Study, and JICA dispatched a Basic Design Study Team between November 16th to December 14th, 2006, and a Draft Basic Design Report Explanation Team from March 12th to 19th, 2007, to Tuvalu.

The study revealed that the deepwater wharf is in great danger of collapsing, and hence, it was deemed necessary to construct a new jetty to the south of the current jetty, with consideration given to the natural conditions of the construction site and use conditions of the existing jetty. In addition, it was determined to exclude the provision of an office of the Department of Fisheries, a slipway, reefer containers, etc. from the scope of the project, because it is difficult to ensure conformity to the project aimed at maintaining the port functions for the safe and smooth landing of goods. In planning the facilities and equipment to be covered by the project, as a basic policy, low-cost maintenance after completion of the project was taken into account. Accordingly, the scale and contents of the project were fixed as follows, to be appropriate as a grant-aid scheme, and by examining the background and contents of the request and the natural conditions, maintenance structure, construction situation, etc., in the country, through a field survey and analytical work in Japan.

1. Facility

Facility	Structure, specifications, etc.	Scale
1) Civil engineering facilities		
L-shaped jetty	Foundation: Steel pipe pile type Upper structure: Reinforced concrete	Length: L80.0 m x W16.0 m + L50.0 m x W12.0 m
Access bridge	Structure: Same as above	L51.5 m x W8.0 m
Quay for fishing boats	Reinforced concrete	Length: 12.0 m with steps
Seawall	Concrete seawall	Length: 103 m (H = 1.45 m)
Container yard	Gravel pavement	600m^2
Mooring dolphins	Use of piles and concrete	Size of target vessels: 3,000 tons, 2 berths
Navigation aids	Steel pipe pile-type single beacon	With radar reflector, 1 berth

Facility	Structure, specifications, etc.	Scale
2) Ground facilities		
Repair of the warehouse	Steel frame structure	Floor area: 875m^2
Roof/walls	Replaced by aluminum steel sheets	1 lot
Roll shutter	Replaced by hanger doors	1 lot
Water collecting fittings	Replacement of eaves gutter, etc.	1 lot
Water Tank	Reinforced concrete structure	Capacity: app. 600m^3 L15.7 m x W16.7 m x H2.3 m

2. Equipment

Equipment	Specifications, etc.	Quantity
	(For transporting 20-foot containers)	
Forklift	Maximum load: 25 tons, lifting height: 3 m	1 unit
Trailer	Platform dimensions: 6,200 mm x 2,500 mm	1 unit
Tractor	Maximum towable weight: 50,000 kg	1 unit

If this project is implemented under Japan's grant-aid scheme, it will require 20.0 months in total as the implementation schedule, consisting of 5.0 months for detailed designing and 15.0 months for construction of the facilities and procurement of the equipment. The total project cost is estimated at 921 million Japanese yen, of which Japan will contribute 917 million, while Tuvalu is responsible for the remaining 3.6 million. In addition, the maintenance cost is roughly estimated as 53,905 Australian dollars per year, a level that is easily affordable for the recipient country to carry out maintenance work, and thus it is deemed no problem.

The implementation of the project is expected to bring the following effects in the aspects of development of Tuvalu's regional economy, through promotion of fisheries, and of issues to be addressed in the distribution sector that provides the basis for the livelihood of the Tuvaluans.

Current status and issues	Measures to be taken in the project	Direct effects and the degree of improvement	Indirect effects and the degree of improvement
The deepwater wharf is in great danger of collapsing due to the aging of its reinforced concrete, requiring the maximum weight of cargo in a container to be restricted and causing hindrance to efficient use of marine transportation. Furthermore, as it is the only jetty in Tuvalu where large-scale vessels can moor, it is anticipated that, if it collapses, the livelihood of the Tuvaluans will also likely collapse.	・Construction of a new jetty	i) The restriction on the weight of 20-foot containers will be alleviated from the current across-the-board threshold of 18 tons to by-container norms with a total combined maximum weight of between 20 and 30 tons. ii) If the safety of the jetty is established, it can be used for a long period.	i) The project is expected to contribute to the stabilization of the rural economy of Tuvalu through promotion of fisheries in outer islands where income generation opportunity is low. ii) The cargo volume per container will increase, thereby contributing to the reduction of transport costs.

Current status and issues	Measures to be taken in the project	Direct effects and the degree of improvement	Indirect effects and the degree of improvement
Cargo handling-related work inevitably needs to be conducted on public roads, requiring extra man hours. Further, containers are also temporarily placed on public roads due to the lack of space available for container storage on the premises, which impedes the safe passage of citizens.	・Construction of a new jetty to the south of the existing wharf. ・ Development of internal aisles ・Development of the container yard	i) The time required to transport 20-foot containers from the jetty to the yard will be shortened from 2.5 minutes to 1.5 minutes approximately. ii) The number of loaded containers that can be stored in the yard will increase from 40 to 60 approximately.	i) The improved efficiency of cargo-handling works will reduce the time required for containerships to stay at the jetty, thereby contributing to the reduction of transport costs. ii) Eliminating transportation and storage of containers on public roads will ensure the safe passage of citizens.
The short mooring berth length causes the mooring line for Nivaga II's to be an obstacle to the access of other vessels.	・Development of a jetty with 80m-long berths	i) The problems brought about by the mooring of Nivaga II (9.1 days/month) will be solved.	i) Access of vessels to the port will be easier, providing greater convenience as a harbor.
In addition to the lack of cargo-handling equipment, the aging of the current equipment frequently causes failures, hampering cargo-handling activities.	・Provision of a forklift (25-ton), trailer and tractor	i) Interruption of cargo handling works due to the failure of cargo-handling equipment will significantly be improved.	i) The improved efficiency of cargo handling of containers is expected to reduce the length of time for containerships to stay at the jetty.
Due to the limited water storage capacity, if the amount of rainfall is low, freshwater to be supplied to inter-island vessels is not sufficient, hence requiring the vessels to postpone their departure and causing further hindrances to the safe operation of the vessels.	・ Repair of the warehouse ・Construction of the water tank	i) The water storage capacity will be expanded from 150m^3 to 750m^3.	i) The improved capacity to supply freshwater to inter-island vessels will contribute to the stabilization of ship operations.

In addition to the above effects, this project is expected to contribute to the stabilization of Tuvalu's regional economy through the maintenance of the Tuvaluans main lifeline and promotion of fisheries in the outer islands where income opportunities are poor. The number of beneficiaries is estimated at approximately 9,500 covering the capital, Funafuti, as well as the other outer islands. Thus, it is deemed as appropriate to implement this project under Japan's grant-aid scheme.

For the purposes of utilizing the facilities and the equipment, including existing ones, after completion of the construction and repair of the facilities under the project, and improving logistics in the country, it is proposed to give due consideration to the following points:

(1) Securement of spare parts and budget for cargo-handling equipment

The breaking down of cargo-handling equipment seriously impacts on the cargo-handling work at the port. Securement of spare parts for the equipment is therefore vital for maintaining efficient cargo-handling work, but unfortunately it takes a significant amount of time to procure spare parts,

including the time required for transport. Therefore, it is essential to secure a minimum quantity of spare parts at the beginning as well as preparing for smooth procurement, such as listing up of inventory, procurement sources, prices, etc. Also, it is imperative to earmark a certain budget for the purchase of spare parts.

(2) Improvement of maintenance skills

The maintenance work for the equipment shall be carried out by personnel of the Department of Marine as has always been so. The equipment to be provided by the project requires similar technical skill levels to the existing equipment, and so the Department of Marine is of course capable of maintaining the new equipment. In the meantime, however, it is called for to share repair techniques among all the maintenance personnel and also to strive for realizing periodical maintenance to prevent failure and improving maintenance skills.

(3) Improvement of cargo-handling equipment

In order to lower marine transportation costs, it is important to shorten the time required for containerships to stay at the jetty. Since nighttime operation of large-sized vessels is prohibited at the Funafuti lagoon for safety reasons, if a ship enters the port early in the morning, she must finish the cargo handling work and depart before dark at the latest. In order to realize this, it is necessary to shorten the time required to transport containers from the jetty to the container yard, which currently occupies the largest portion of the cargo-handling time. Since this project only provides one pair of container transporting vehicles, the Tuvaluan side is expected to purchase another set so as to achieve a higher level of cargo-handling efficiency.

(4) Establishment of a cooperative mechanism for efficient cargo handling

The cargo-handling workers at the port officially belong to the Department of Marine, but in their actual work of handling imported goods, they follow instructions by TCS, which is the largest consignee and has the greatest experience in import activities in Tuvalu. Because the workers are paid by the Department according to working hours and TCS is responsible for these costs, the Department and TCS, which wants to reduce costs by minimizing working hours, are not necessarily on the same track in terms of interests. In order to ensure efficient cargo-handling work after the completion of the project, collaboration with TCS, which is a cargo-handling expert, is as vital as the present, and therefore, it is deemed necessary to revise the operation mechanism, including a review of the billing system.

(5) Maintenance and inspection of the facility

Since the Department of Marine does not have an internal construction unit, they request the PWD to repair the existing jetty when needed. In view of the fact that the jetty is the country's irreplaceable, key logistics facility, adequate maintenance is called for so as to contribute to the social and economic activities of the country. In order to soundly maintain the functions of the jetty in the future, it is vital to

detect damage as early as possible and implement accurate and proper corrective actions accordingly. To this end, the cooperative relationship between the Department of Marine and the PWD concerning regular inspection and repair must be strengthened for continuing maintenance activities after implementation of the project.

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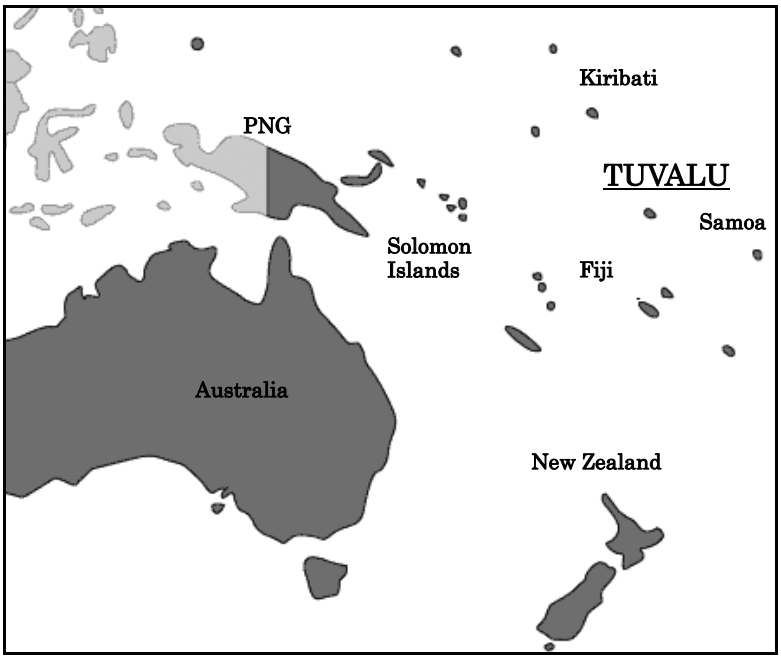
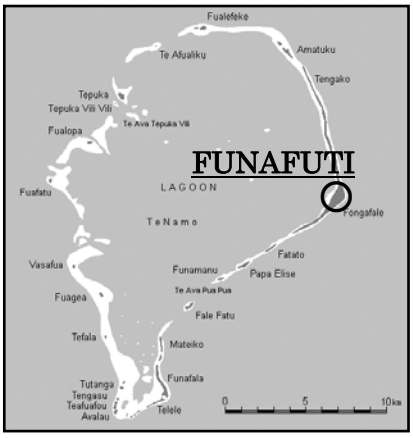
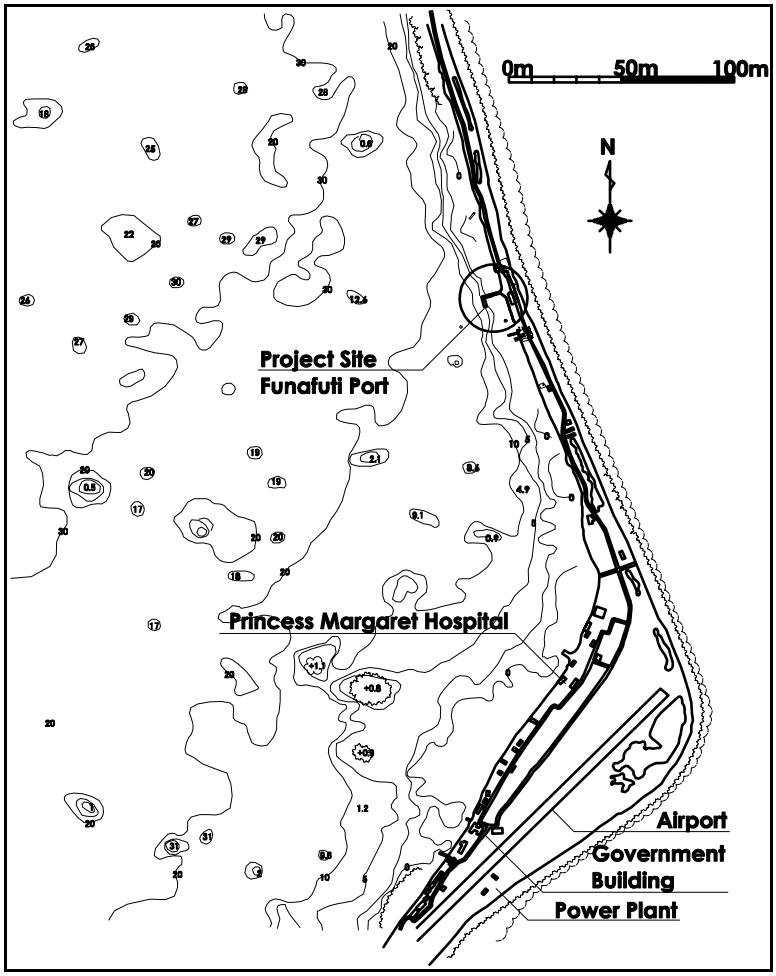


Location of Tuvalu





Map of Project Site

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Abbreviations

ADB	Asian Development Bank
C.D.L.	Chart datum level
CFC(s)	Community Fisheries Center(s)
D.L.	Datum level
EEZ	Exclusive economic zone
EIA	Environmental impact assessment
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
G.L.	Ground level
GRT	Gross tonnage
H.H.W.L.	Highest high water level
H.W.L.	High water level
IEE	Initial environmental examination
ISPS	International Ship and Port facility Security (Code)
JICA	Japan International Cooperation Agency
LDC	Least developed countries
IMO	International Maritime Organization
L.W.L.	Low water level
M/D	Minutes of Discussions
M.H.W.L.	Mean high water level
M.L.W.L.	Mean low water level
M.S.L.	Mean sea level
M.W.L.	Mean water level
NAFICOT	National Fishing Company of Tuvalu
OFCF	Overseas Fishery Cooperation Foundation
PC	Precast concrete
PVC	Polyvinyl chloride
PWD	Public Works Division
RC	Reinforced concrete
SPC	South Pacific Commission（Renamed to Pacific Community）
TCS	Tuvalu Cooperative Society Ltd.
TTF	Tuvalu Trust Fund

Chapter 1. Background of the Project

1.1. Background of the request

The deepwater wharf is Tuvalu's only jetty where large ships and inter-island vessels can approach and moor, and, as a result, all imported goods including daily necessities and essential fishing equipment, such as fishing gear, outboard motors, etc., are landed at Funafuti Port. As there are no domestic flights in the country, the transport of people as well as goods between Funafuti and the eight outer islands solely depends on the two inter-island vessels owned by the government. Some of the fish caught in the outer islands is transported to Funafuti by the inter-island vessels or Manaui, allowing precious cash income to flow into the outer islands while contributing to the supply of fish to Funafuti. In this way, Funafuti Port, which is the central base of inter-island transportation of people and cargo in the country, plays a significant role in supporting the foundation of the livelihood of the Tuvaluans.

Nevertheless, the deepwater wharf, which has been in use for a quarter of a century since its construction, is rather decrepit and hence its load bearing capacity has been decreasing. As a result, the allowable weight of a container to be unloaded on the jetty is restricted to 18 tons or below. If this threshold is exceeded, it is required to take some cargo out of the container on the deck of the containership so as to reduce the container weight. Furthermore, the efficiency of cargo handling at Funafuti Port has been undermined due to the lack of container transporting equipment together with the fact that the only large-size forklift that can lift containers is superannuated and frequently breaks down. The lower cargo-handling efficiency forces containerships to stay at Funafuti Port for longer, which, combined with the restricted cargo weight per container, pushes up transportation costs. Moreover, as the length of the jetty is not long enough, when a containership or Nivaga II is mooring, the mooring lines disturb the ship course, inhibiting the access of other vessels.

The fisheries jetty to the south of the deepwater wharf has also aged significantly and there is the possibility of it collapsing if Manaui approaches and moors. Therefore, all landing work is conducted at the deepwater wharf instead. Additionally, as rainwater is an important source of daily-use water in Tuvalu, when precipitation is not sufficient in some years, inter-island vessels occasionally need to postpone their departure due to the lack of water onboard, which consequently hinders the establishment of stable marine transportation. The Warehouse, though its roof functions as a rainwater catchment area, is faced with a variety of problems caused by aging, such as rainwater leakage, fracture of eaves gutters, failure of opening and closing of the roller shutter, and so forth, and thus is unable to store goods in bond in an adequate manner. Moreover, containers are temporarily placed on and transported via public roads due to insufficient space in the port area, posing security- and safety-related concerns.

In this way, as Funafuti Port is ridden with various problems that need to be addressed, improvement of the port, including the construction of an alternative jetty, is an urgent need. That being the case, the government of Tuvalu formulated a "Funafuti Port Improvement Plan" for the purpose of maintaining the safe and smooth landing functions of Funafuti Port, and, to do so, requested grant-aid assistance from the government of Japan in June 2005.

1.2. Natural conditions of the project site

(1) Geography

Appendix 6-2 shows the results of topographic and sounding surveys. The referential control point is set at the national benchmark of B.M.22 (D.L. + 4.0123 m), approximately 300m to the south of the project site. The reference level adopted in these surveys (D.L. ± 0.00 m) is the Australian standard for the reference of the sea-level rise monitoring system, and although it is about 1m below the reference level indicated on commercially available nautical charts, considering that the country follows the reference level set by Australia at present, the same basis shall be selected and used in the project as well. In addition, when planning the ship course, it is important to pay attention to the patch reef with a water depth of -4.7m at a point roughly 300m away from the existing wharf to the south-southwest.

(2) Geology

For the purpose of examining the jetty structure, a boring survey was conducted at four points in the vicinity of the planned construction site for the new jetty. The survey results are provided in Appendix 6-3 and the soil character constants are set as follows:

Bedrock	N	=	50 or more
Weight per volume in air	γ	=	18kN/ m^2
Weight per volume in water	γ'	=	10kN/ m^2

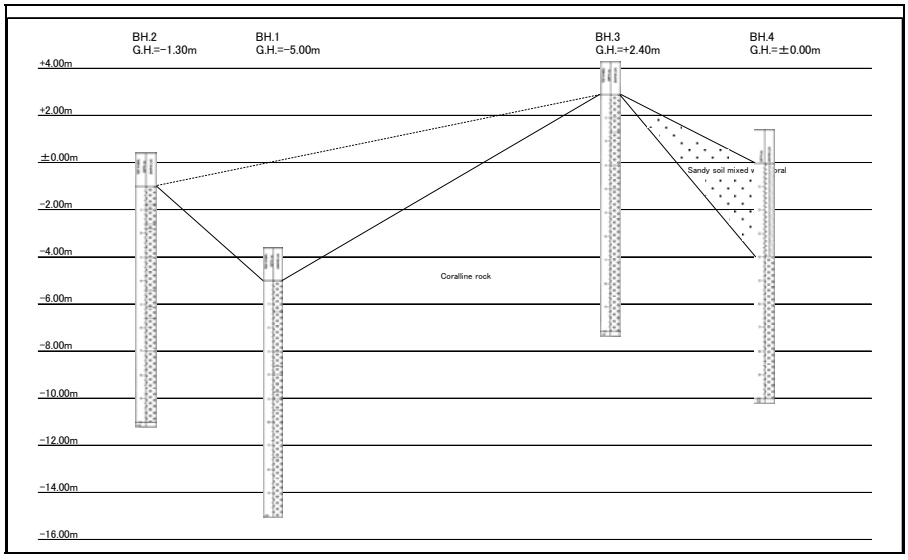


Fig. 1-1: Cross section of estimated soil layers

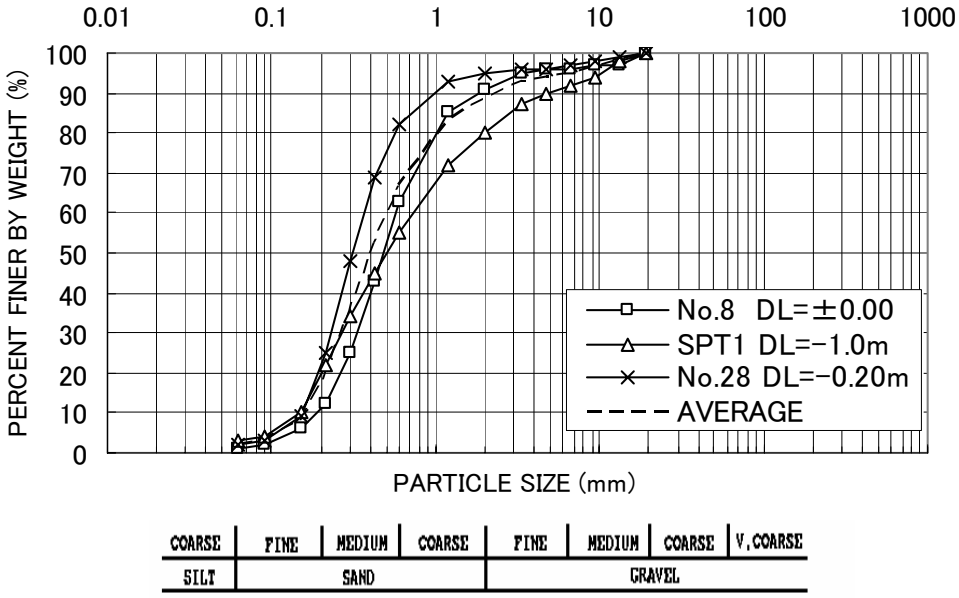


Fig. 1-2: Particle-size accumulation curve

(3) Oceanography

1) Tide level

Fig. 1-3 below shows the design tide levels. The levels have been determined based on the tide levels observed in 1983.

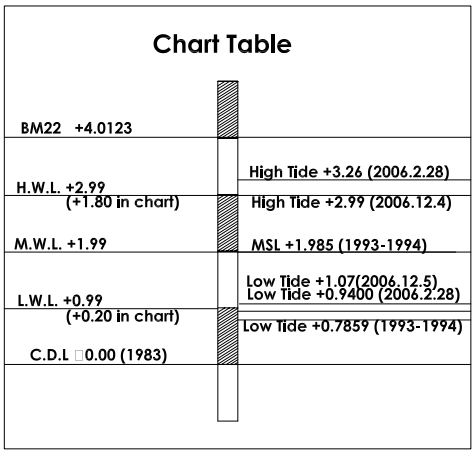


Fig. 1-3: Design tide levels

2) Waves

Since the entry of waves from the Pacific Ocean requires no consideration at the project site, winds and waves within the lagoon alone are to be calculated. Assuming that the travel distances (fetches) are 10 km on the north side and 15 km on the west side, the offshore wave heights can be calculated as 2.2m with a period of 5.6 sec, based on a wind speed of 26.1 knots during a cyclone, referring to the 50-year recurrent wind speed actually experienced in the past. With consideration given to the geographical

conditions at the target point, the significant wave height and the maximum wave height are calculated as 2.1 m and 3.8 m, respectively.

3) Currents, drifting sands, coastal geography (deformation)

An interview survey in Tuvalu found that there has been no significant change in the coastal line due to erosion and deposition in the lagoon. Further, the current facility is a pile-type jetty pass-through structure, and there is no particular sign of movement of sands toward the coast.

When a spring tide occurred on November 21st, 2006, during the field survey, continuous observation over wave currents was conducted at the interim layer 10m below the water surface, for 25 hours at 4 m above the seabed level and 16 hours at 6 m above the seabed level. As a result, the observation value at the site was 0.1m/sec at maximum, mainly flowing in the cross-shore direction, and no currents were observed in the coastal direction or other specific directions. Thus, it is considered that the construction of a new structure will cause virtually no geographical changes.

1.3. Environmental and social considerations

(1) Impact on the environment and society

This project involves construction of a jetty, and hence there is the possibility of having an impact on the coastal natural environment. Thus, it is deemed to fall under Category B in accordance with the "JICA Guidelines for Environmental and Social Considerations". For this reason, the details of environmental and social impacts were reviewed by examining the checklist of scoping carried out by the Tuvaluan side in advance. The results of the review are provided hereunder.

1. Resettlement

The project site is situated in a zone designated as a port area where both commercial and fishing port activities already take place. Therefore, there are no inhabitants in this area, requiring no need for relocation of residents.

2. Economic activities

There is no need for appropriating private land in conjunction with the implementation of the project. Moreover, there are no fishermen who live on fishing in and around this port area. Thus, these is no stakeholder who will lose his/her living or economic base because of the implementation of the project.

3. Traffic and public facilities

Although the project will construct a new jetty to replace the existing superannuated jetty, any significant increase in the number of vessels that will use the port is not expected. Further, it is not likely that the onshore traffic will increase as a result of the implementation of the project.

4. Regional split

Since the project site is limited to inside the port area, there is no potential for causing the severance of

communities.

5. Culture property

Since there are no relics, temples, or any kind of buried cultural assets in or around the port area, there is no risk of destroying any precious cultural assets, etc., as a result of the implementation of the project.

6. Water rights and common rights

There is no problem identified in the port area, concerning water concession, commonage, right to frontal water, etc.

7. Health hygiene

Daily wastes and wastewaters are adequately treated and disposed of within the port area. However, including the construction period, it is still necessary to closely monitor the treatment of garbage.

8. Waste

There are no factors that will lead to the increase in discharged wastes during the implementation of the project. There is also no concern that a large amount of waste will be generated and left unattended during construction. A small quantity of waste can be disposed of in an appropriate manner.

9. Hazards

The project is free from any factor that has the potential of causing a ground failure. However, since there is a patch reef on the ship course that will be newly set in accordance with the construction of the new jetty, it is necessary to put up a sign as a countermeasure warning of the danger of hitting the bottom.

10. Topography and geology

There are no topographical or geological points that need to be preserved within the port area. Besides, the project does not involve any large-scale civil engineering, such as excavation, backfilling, dredging, reclamation, etc.

11. Soil erosion

Since the project does not involve any land development or deforestation that requires large-scale reclamation, there is no potential for causing soil erosion.

12. Groundwater

Groundwater is not used in and around the port area. Also, there is no plan to pump up groundwater for the project. Thus, it does not have the potential of becoming a problem.

13. Hydrological situation

There is no lake or river in and around the project site. Thus, it does not have the potential of becoming a problem.

14. Coastal zone

In the project, no work involving large-scale dredging or reclamation is planned. A survey on drift sand, deformation of coastal landforms, and the status of tidal currents found no evidence of an impact of the existing jetty on the coast and sea area. Therefore, it is most probable that any impact on the coast and the sea area can be minimized by adopting the pile-type structure, the same as the existing jetty, for the new jetty. During the construction period, white turbidity will occur in the seawater arising out of uprolling of sand and soil at the time of pile-driving works. However, as the range of the occurrence is limited, it is not expected to impact the local ecosystem. Construction in the project shall be carried out with due attention paid to the minimizing of possible impact on the sea area.

15. Flora and fauna

The project site is limited to inside of the port area where no rare flora and fauna to be protected exist. The Marine Conservation Area is situated west of the Funafuti atoll on the opposite side of the project site, a distance of roughly 10 km. Thus, it is considered that the impact of the implementation of the project on the local ecosystem will be extremely low.

16. Weather

The project is free from any factor that has the potential of causing a climate change.

17. Landscape

The project site is designated as a port area, therefore, there is no concern about affecting the natural the scenery.

18. Air pollution

The project is not expected to lead to an increase in the number of vessels or vehicles.

19. Water pollution

As previously mentioned, there will be some turbidity of seawater during the construction period, but the turbidity substances will mainly consist of sand and soil that will not bring any fundamental adverse effect to the water quality. While there has been no report on water pollution due to vessels, it is still important to conduct monitoring.

20. Soil contamination

Though the concern is minimal, it is still necessary to take adequate management actions to prevent any leakage of oils, toxins, etc., from cargos.

21. Noise and vibration

There are no residents living in the port area. There have been no harmful noises or vibrations reported from the existing facilities. Though noise and vibration that will be generated during the construction period and at the time of cargo handling activities will remain within the allowable range, it

is necessary to take all possible measures to mitigate them through appropriate management at the site.

22. Land subsidence

The project is free from any factor that has the potential of causing subsidence due to change in geological conditions or decline of the groundwater level.

23. Offensive odors

Though the project itself is free from any factor that has the potential of causing bad odors during the construction, cargos to be handled may include fresh and frozen foodstuff, animals and marine products. Therefore, it is vital to maintain the sanitary condition of the port area and implement appropriate management measures to prevent abnormal odors.

Table 1-1 : Results of review of the Provisional Scoping Checklist

Environmental Items			Pre-assessment by the Government of Tuvalu		Facts Identified by the Field Survey
			Evalu-ation	Reason	
Social Environment	1	Resettlement	D	Facilities that require resettlement of residents are not included in the project.	Same as left （no concern）
	2	Economic activities	D	No impact is expected since existing port and fishing activities are not affected by the project.	Same as left （no concern）
	3	Traffic and public facilities	D	Number of ships, fishing vessels and vehicles will not increase due to the project. No impact is expected since project site is already designated as the port area and the fishing port area.	Same as left （no concern）
	4	Regional split	D	No impact is expected since project site is located in the port area and the fishing port area.	Same as left （no concern）
	5	Culture property	D	No impact is expected.	Same as left （no concern）
	6	Water rights and common rights	D	No impact is expected since commercial and fishing port activities are already undertaken.	Same as left （no concern）
	7	Health hygiene	D	No impact is expected since garbage and debris will not be generated.	Same as left （It is however necessary to carefully monitor the status of waste disposal.）
	8	Waste	D	A large quantity of construction waste and debris will not be generated. Possible small quantity of waste that will be treated properly.	
	9	Hazards	D	No impact is expected.	It is necessary to install signs at the patch reef.
Natural Environment	10	Topography and geology	D	A large quantity of excavation and filling will not be generated. Dredging and reclamation are not planned in the project.	Same as left （no concern）
	11	Soil erosion	D	Creation and reclamation of land are not planned in the project.	Same as left （no concern）
	12	Ground water	D	No groundwater pumping and utilization of facilities are planned.	Same as left （no concern）
	13	Hydrological situation	D	No lake and river is located in the vicinity of the project site. No lakes or rivers are located in the vicinity of the project site.	Same as left （no concern）
	14	Coastal zone	C	Few impacts to littoral drift and tidal current are expected since wharf structure will be piled jetty type. Dredging and reclamation are not planned in the project.	Though white turbidity of seawater will occur as a result of uprolling of sands and soil at the time of pile-driving work, the range of impact is limited, and hence it can be assessed as D.
	15	Flora and fauna	D	Project site is located in the port area and the fishing port area. Since dredging and reclamation are not planned in the project, no impact on aquatic plants and animals is expected.	Same as left （No rare flora and fauna exists within the port area.）
	16	Weather	D	No impact is expected.	Same as left （no concern）
	17	Landscape	D	No impact is expected since the project site is already designated as the port area and the fishing port area.	Same as left （no concern）
Pollution	18	Air pollution	D	No impact is expected since the number of ships and vehicles won't increase due to the project.	Same as left （no concern）
	19	Water pollution	D	Since dredging and reclamation are not planned in the project, no impact is expected.	Same as left （It is necessary to monitor water pollution by vessels.）
	20	Soil contamination	D	No impact is expected.	Same as left （Management is needed.）
	21	Noise and vibration	D	The level of noise and vibration generated from planned facilities are to be controlled by construction supervision and on-site management of facilities operation.	Same as left （No significant noise or vibration has been confirmed from the existing facilities.）
	22	Land subsidence	D	No impact is expected.	Same as left （no concern）
	23	Offensive odors	D	No impact is expected.	Same as left （Management is needed.）

Note : Evaluation classification

A: Expected serious impact　　B: Expected somewhat impact

C: Not clear　　D: IEE or EIA is not necessary (no expected impact)

(2) Procedures necessary for the environmental assessment

The Department of Environment of the Ministry of Natural Resources and Lands is the agency in charge of environmental issues. Usually, prior to the start of a construction project, an EIA officer and the project task force play the role of the responsible body to examine the necessity for conducting an environmental assessment. If it is determined as necessary, they proceed with a series of steps, such as the determination of the timing to start the assessment, selection of EIA consultants, and evaluation of the EIA report. The length of time required for the evaluation depends on the details of the project, but is roughly two weeks for IEE and maximally six months for EIA.

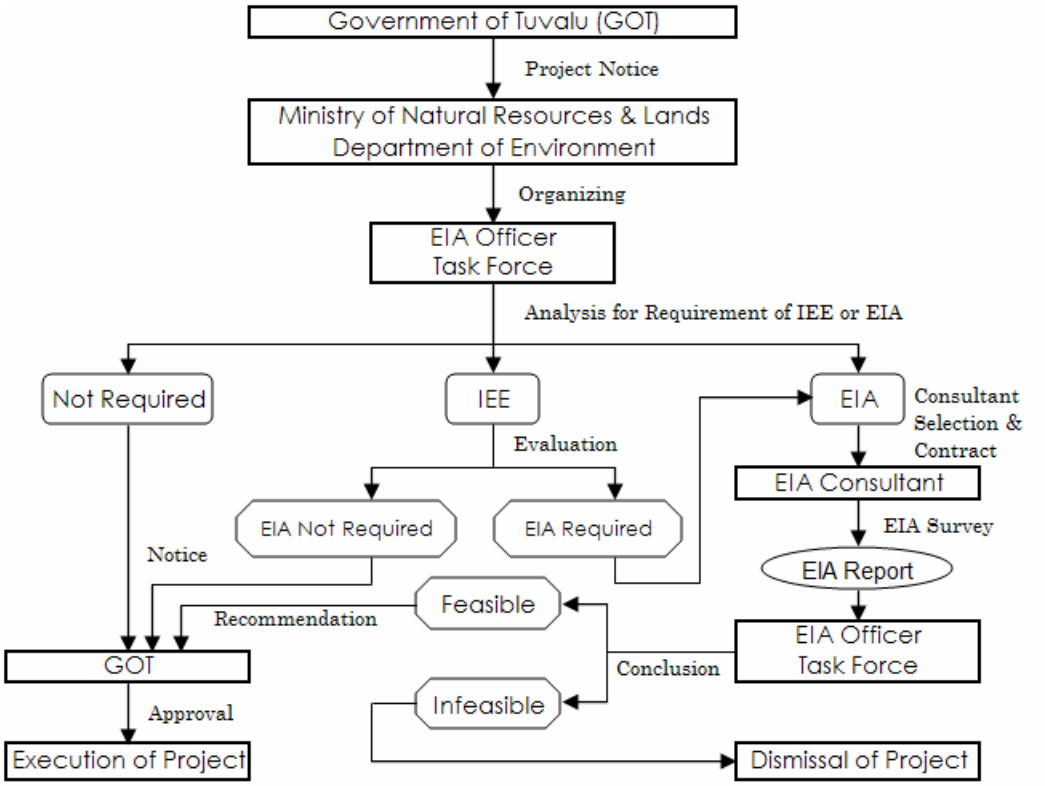


Fig. 1-4： Procedural flow-chart of the environmental assessment

This project is on a relatively large scale, involving construction of a water-edge facility. Therefore, the government of Tuvalu conducted an IEE in March 2006, in order to ascertain any possible negative impacts of the project, especially on the marine ecosystem. As a result, it was confirmed that there was no need for conducting an EIA in order to implement this project, and this conclusion was accordingly communicated to the Japanese side.

Chapter 2. Contents of the Project

2.1. Basic Concept of the Project

2.1.1. Inputs of the project

The components of the project were narrowed down giving priority to the facilities and equipment indispensable and urgently needed for assuring the safe and smooth landing of goods at Funafuti Port. As a result, of the requested components, the slipway, the office of the Department of Fisheries, and reefer containers have been excluded from the scope of the project, since they are not fully compliant with the purpose of the project. Furthermore, when redrawing the zoning in accordance with the change in the distribution traffic lines from the perspective of effective use of the premises, the Tuvaluan side will be find it necessary to relocate the existing cement shed/equipment workshop at its own cost.

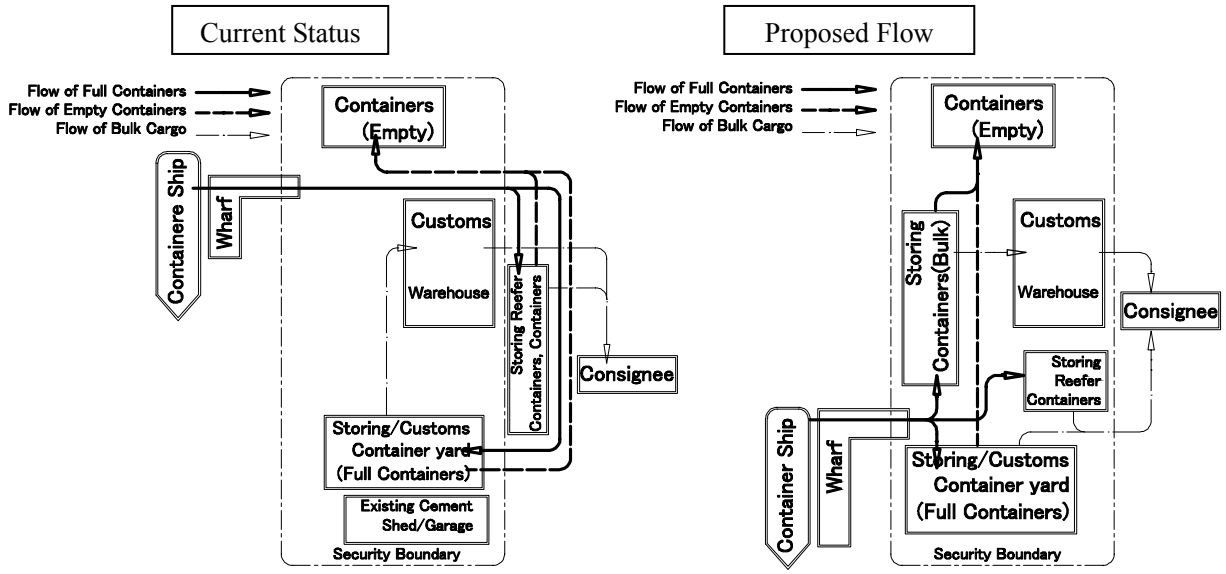


Fig. 2-1: Plan for zoning and traffic lines

As a part of the field survey, the study team held discussions with the project task force on the Tuvaluan side, and thereby confirmed the contents of their request, the respective priorities, and appropriateness as components to be included in the project. The results of the evaluation are provided as Table 2-1 below.

Table 2-1: Contents of the request and items to be included in the project confirmed by the Basic Design Study

Requested item	Priority	Result of evaluation on appropriateness to be included in the project
Jetty	A	As it is the most important facility in terms of distribution in Tuvalu, it is included in the project together with power supply, security lamps, and other necessary functions.
Repair of the warehouse	B	As it is imperative to repair the existing warehouse to retain the bonded storage function and the rainwater catchment area, it is included in the project.
Water tank	A	As the securement of the water supply to vessels is regarded as a necessary measure for stable sea transportation, it is included in the project together with water supply system.

Requested item	Priority	Result of evaluation on appropriateness to be included in the project
Repair of the slipway	B	It is excluded from the project as it is not compliant with the purpose of the project. As OFCF's cooperation has enabled the winching of Manaui and hence, though limited, the immediate necessary functions have been restored.
Repair of the office of the Department of Fisheries	B	It is excluded from the project as it is not compliant with the purpose of the project. Though the fact that the staff is deployed over several different areas seems to cumber the efficiency of work, the space for the workers is sufficient and hence the urgency for improvement is considered as low.
Forklift	B	Since this equipment is indispensable for cargo handling at ports and the existing equipment is significantly decrepit, it is appropriate to replace the existing equipment in the scope of the project.
Sidelifter	B	In order to assure efficient cargo handling, it is deemed as appropriate to provide a trailer and a tractor in place of sidelifters.
Reefer container	C	It is excluded from the project as it is not compliant with the purpose of the project. The distribution of the fish catch is to be covered by NAFICOT, and also it is more desirable to effectively utilize the existing cooling facility of NAFICOT than procuring new reefer containers.

A: Improvement urgently needed

B: Important but further examination is necessary

C: Necessary but technical and economical examination on the appropriateness is necessary

(1) Jetty

A survey on the level of deterioration of the existing jetty has found that the jetty is seriously decrepit, particularly the upper structure, which is so superannuated that it may collapse at any time. Consequently, it was deemed as necessary to wholly renovate the jetty. The deepwater wharf is the most important facility for shipping in Tuvalu, and thus it is deemed as appropriate to construct a new jetty, so as to secure the safety of passengers and cargo handling activities and also enable the continuous use of the facility over the coming years.

(2) Port facilities on land

1) Warehouse

Improvement of the warehouse is necessary for securing efficient cargo handling work as well as the port security system in compliance with the International Ship and Port Facility Security (ISPS) Code. Further, the roof of the warehouse serves as a rainwater catchment area and hence it is also essential in terms of securing a stable water supply for vessels. Accordingly, it is deemed necessary to urgently repair the exterior finishing materials including the eaves gutter, reinforce the steel materials, and repair and paint the roll shutters.

2) Water tank

Currently, the Public Works Division (PWD) supplies vessels with freshwater. However, the desalination devise that the PWD owns was provided through a grass-root grant aid project for the community to use. At a time of drought, even the Funafuti islanders suffer from a lack of water. Under such circumstances, the inter-island vessels sometimes must delay trips because of the lack of freshwater.

Thus, in order to secure the stable operation of vessels and subsequent distribution throughout the country, it is deemed as necessary to upgrade the capabilities of the current 150m^3 water tank and also to provide an additional storage tank.

3) Improvement of the seawall and the passages inside the site

Though the existing seawall is the western border of the premises, its crown height is not enough to prevent waves from overtopping into the container yard at a time of rough weather, and further it is not even usable as a traffic lane due to a lack of space in front of the warehouse. In order to secure efficient cargo handling by rearranging the traffic lines, it is deemed as very necessary to effectively utilize the premises, as part of the seawall improvement in accordance with the construction of the new jetty, by making the west side of the warehouse more practical through redevelopment of the container yard and the internal passages.

(3) Equipment

1) Forklift (25 tons)

The Department of Marine currently uses a 25-ton forklift that was purchased secondhand from New Zealand. This machine, however, is already more than ten years old, and hence it frequently breaks down, while it is difficult to procure spare parts. It is the only large-size forklift in Funafuti, which is capable of handling a 20-foot container fully loaded with cargo. Therefore, when it is out of order and waiting for spare parts to arrive, a sidelifter is hired from Fiji to carry out container discharging. This situation occurs three or four times a year, and it costs, on average, approximately 8,500 Fijian dollars each time, imposing a financial burden on the country.

As a practical matter, cargo handling work must be suspended every time the forklift breaks down; the decrepit forklift is, on occasion. a substantial hindrance to efficient cargo handling activities. Moreover, if the equipment deteriorates further it is considered that the lack of distribution capabilities in Tuvalu will turn into a crisis. Thus, it is deemed as highly necessary to provide a 25-ton forklift under the project

2) Sidelifter

The trailer possessed by the Department of Marine is also severely superannuated, and in fact was out of order due to the breaking down of the suspension for the entire duration of the field survey. Furthermore, the islanders do not have a tractor to tow the trailer. As a result, the container transporting work is barely fulfilled by a trailer borrowed from Tuvalu Cooperative Society Ltd. (TCS) and a tractor from the PWD.

As a sidelifter is attached with a loading/unloading devise to transload containers, it is regarded as a vehicle that can be used for unloading containers in remote areas where there is no loading/unloading equipment. Since there seems to be considerable demand for such equipment in Funafuti, it will be beneficial that, if loaded containers are transported out of the port area, extra space will be created in the container yard.

Funafuti Island is so small that all houses are packed into an area within 5 km of Funafuti Port, and if a forklift is provided as a means of transportation, it will satisfy these demands to some extent.

Furthermore, in a case of directly reloading a container from the containership to a sidelifter, the attached lifting arms will disturb the work, requiring additional time for unloading work.

On the other hand, it is obvious, from the fact that all the equipment to transport containers between the jetty and the container yard needs to be borrowed, that transportation equipment is in scant supply at the port, though container transporting equipment is essential for achieving efficient cargo handling work. Therefore, it is deemed as appropriate that, instead of the requested sidelifter, the project will provide a trailer and a tractor to pull the trailer.

(4) Miscellaneous

The project will also cover navigation aids that are necessary for the safe sailing of vessels, mooring dolphins needed for tethering, and other port facilities that must be improved in association with the implementation of the project.

In addition, a passengers' anteroom, a watchman's hut, a cement shed/equipment workshop, workshops, etc., are also needed in order to fulfill the port's functions. These facilities shall be developed by the Tuvaluan side in the future through its self-help endeavor.

In summary, the components to be examined under the project are as shown in Table 2-2 below.

Table 2-2: Components of the project

Component	Necessity
Jetty	In order to secure safe and efficient cargo handling work, it is imperative to examine, altogether, construction of a new jetty, improvement of the seawall, redevelopment of the container yard, and setting of mooring dolphins and navigation aids.
Repairing of the warehouse	It is necessary for the adequate storage of goods and collection of rainwater.
Water tank	It is necessary for securing a stable supply of freshwater to vessels.
Equipment	
Forklift (25 tons)	As it is indispensable for cargo handling at a port, replacement of the existing equipment is appropriate.
Trailer and tractor	It is necessary for securing efficient cargo handling.

2.1.2. Basic policy

This project shall be implemented with the aim of improving the facilities at Funafuti Port so that the cargo handling activities at the port, which is the base of distribution in Tuvalu, will become safer and more efficient. The following basic policies are referred to in designing the project:

(i) In designing the jetty, an optimal structure and the most appropriate design approach shall be selected, based on a comparison study in technical and economic terms, with consideration given to the natural conditions at the site, the status of use of the existing jetty, the distribution traffic lines, the positional relationship with the existing facilities, the trend of calling vessels, etc., and the most suitable place shall be determined from the perspectives of use and operation of Funafuti Port.

(ii) The existing port facilities consist of the port office, the warehouse, the workshop, the cement shed/equipment workshop, the janitor's room, the rainwater tank, etc., all of which are

superannuated. In order to maintain normal distribution, it is deemed as vital to at least restore the functions of these facilities. In so doing, the existing facilities shall basically be utilized where possible, and their respective functions shall be restored by repairing them.

(iii) The contents and sizes of the planned facilities and equipment shall be determined with a view to low maintenance cost after the completion of the project.

(iv) The natural conditions at the project site shall be taken into consideration in designing the project. For instance, the project site is surrounded by the sea and hence susceptible to salt damage.

(v) The project shall be designed so as to conform to the laws and regulations of Tuvalu. Particularly, the country acceded to the International Maritime Organization (IMO) in 2004, and therefore the facilities shall be designed as to allow formulation and implementation of security plans that conform to the International Ship and Port Facility Security (ISPS) Code.

(vi) Because the project site is a narrow area, the layout of the facilities shall be planned with consideration given to future use of the premises, and at the same time, the construction work shall be planned in consideration of cargo handling, safety of passengers, securement of the temporary yard, etc., during the construction period.

(vii) Materials and equipment that can be procured in Tuvalu are limited. The majority will have to be procured from Japan or third-party countries. It will accordingly require a significant amount of time for transportation. In light of the nature of the project, namely that it is down to Japanese grant-aid assistance, the procurement plan shall be carefully drawn so as to strictly adhere to the implementation schedule.

(viii) Equipment to be procured under the project shall be selected by referring to the technical level of the existing equipment.

2.2. Basic Design of the Requested Japanese Assistance

2.2.1. Design Policy

The scope of the project shall cover the construction of the jetty, development of the seawall including the container yard, provision of mooring dolphins, navigation aids, a water tank, etc., repair of the warehouse, and procurement of loading/unloading equipment.

The new jetty will be located on the south side of the premises where the impact of, for example, an accident at the oil storage facility is minimal, so that it is easy to expand or extend the premises. In order to secure space for the container yard, the cement shed/equipment workshop at the south end of the premises that are tremendously degraded shall be removed and the land lot shall be prepared by the Tuvaluan side. By converting the south portion of the premises, including the land to be prepared, and the front area of the warehouse into the container yard, it will allow for the storage of 60 loaded containers, 10 reefer containers, and 60 empty containers necessary for the project. Moreover, since it is necessary to develop the front area of the warehouse as a transportation aisle, the seawall shall be extended westward in order to make up for the insufficient width of the premises.

By such a redesigning, the delivery and storage of containers will no longer need to involve public roads, eliminating a potential cause of disturbing the safe passage of the general population. At the same time,

together with the provision of loading/unloading equipment, since the transportation aisle is shortened, the cargo handling work is expected to be made more efficient.

The water tank shall be installed on the south side of the premises, adjoining the existing tank. The watchman's hut, to be provided by the Tuvaluan side, shall be set up near the entrance gate on the south side of the premises where it is close to the new jetty, in order to make it easy to monitor the access of passengers and vehicles.

The north end of the premises will continuously be used as storage for empty containers and dangerous objects, as well as a construction site for the cement shed to be constructed by the Tuvaluan side and a buffer zone for the oil tank.

The following diagram is a rough layout of the cargo traffic lines and the facilities on the premises.

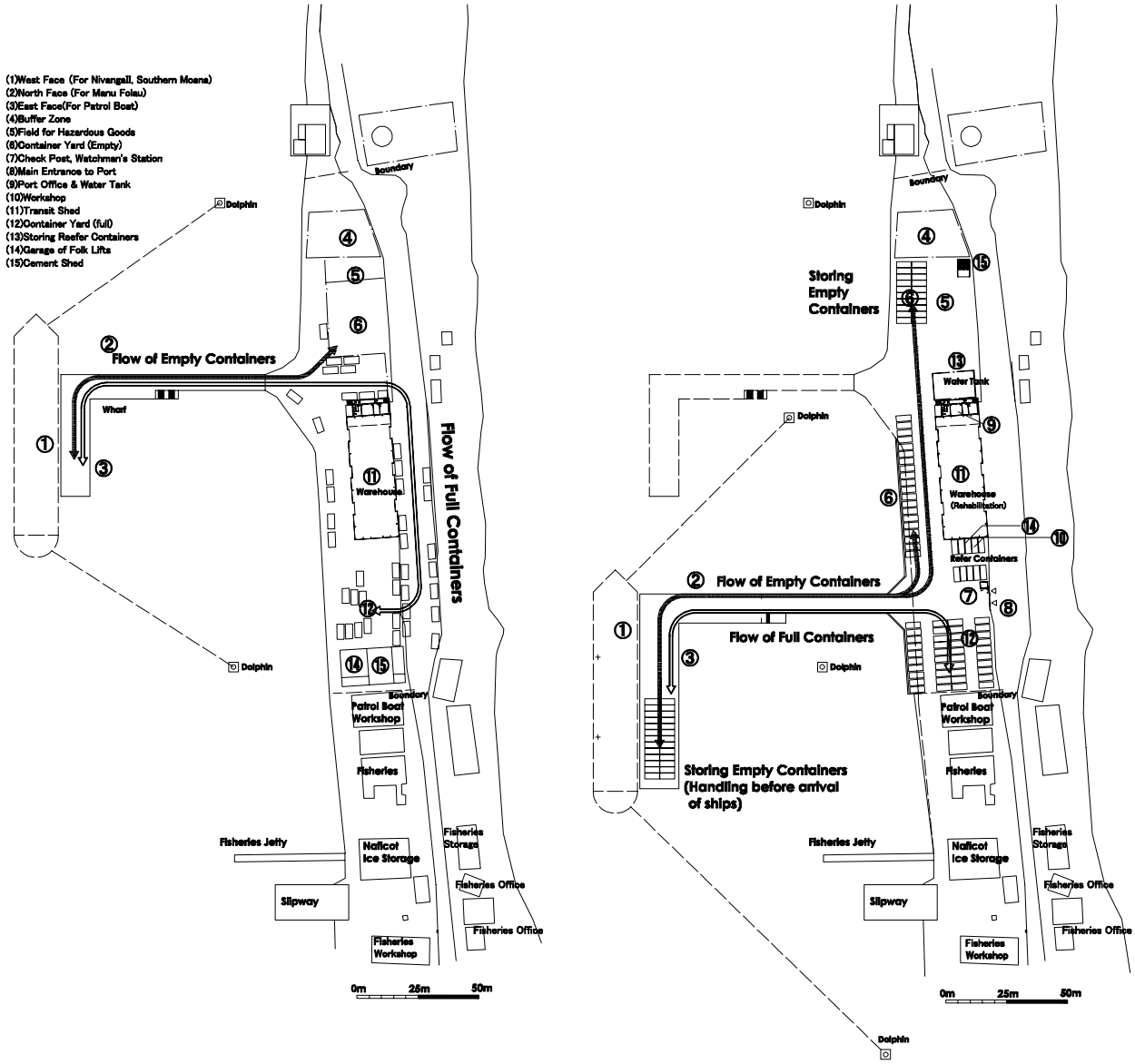


Fig. 2-2: Traffic lines of cargo

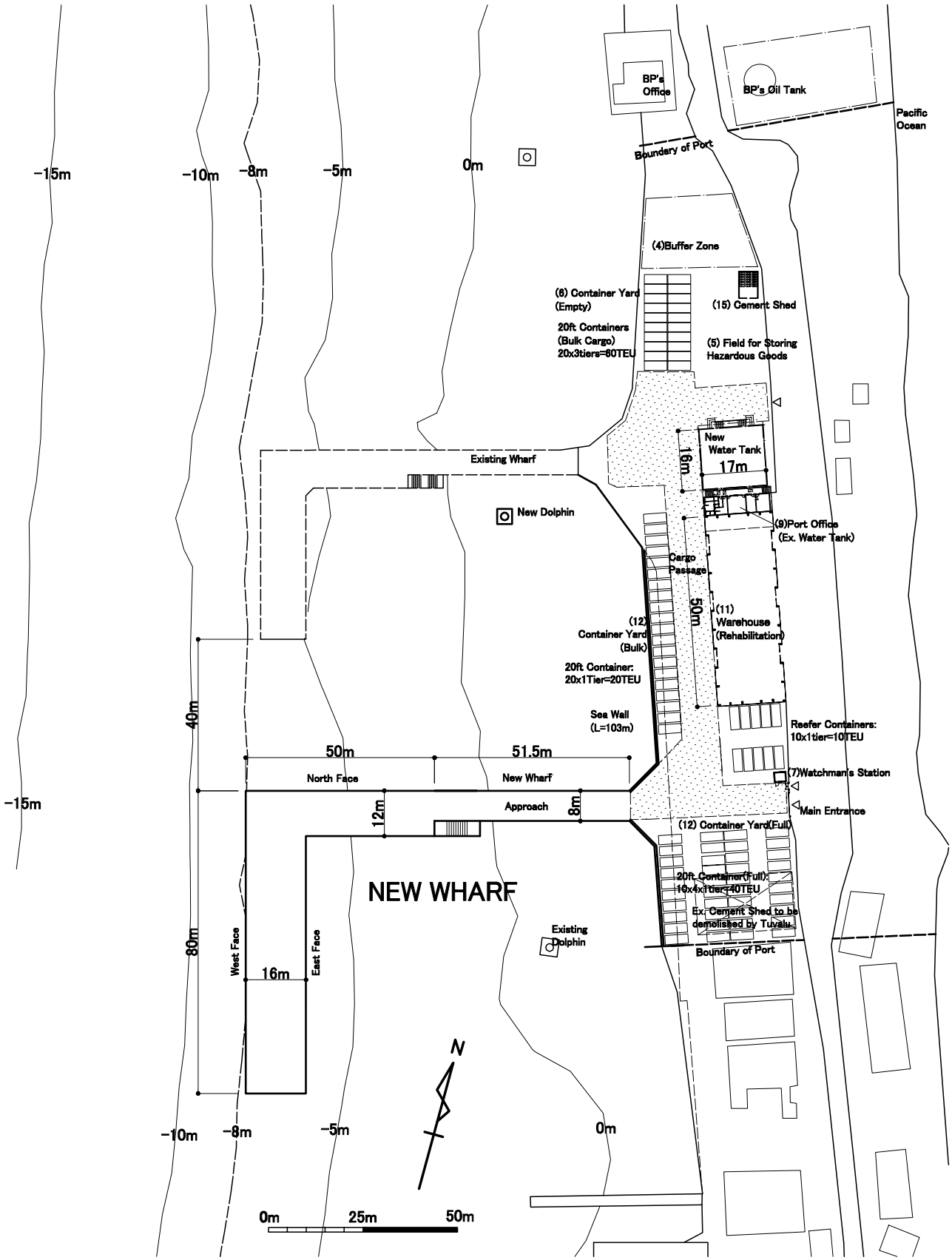


Fig. 2-3： Layout plan

2.2.2. Basic Plan（Construction Plan/Equipment Plan）

2.2.2.1. Jetty

(1) Number of berths needed

Major vessels to be covered by the project, which will use the new jetty, are the Southern Moana, Nivaga II, Manu Folau, Te Mataili and Manaui. International vessels recorded as having entered Funafuti Port include regular cargo ships, ocean-going fishing vessels, irregular cargo vessels, tourist ships, etc. The number of port calls of these vessels, however, varies greatly vary from month to month. Since Funafuti Port is the only international port in Tuvalu and hence it is important to secure a certain number of berths even at a peak time, the number of port calls of international vessels shall be taken as five vessels/month, taking the average of the ten top months out of the three years between 2004 and 2006. As for inter-island vessels, since they operate on a routine basis and the number of port entries is stable, by taking the average of the three years between 2004 and 2006, 2.2 vessels/month for Nivaga II and 3.8 vessels/month for Manu Folau shall be taken as the average. The average number of mooring days of international vessels is 2.18, whereas that of Nivaga II and that of Manu Folau are 4.14 and 5.53, respectively. From these, the necessary numbers of berths for international vessels and inter-island vessels are calculated as in Table 2-3.

Table 2-3： Grounds for calculation of the number of necessary berths

Name of Vessel	Average Number of Port Calls per Month	Average Length of Stay per Call	Average Length of Stay per Month
MV Southern Moana and other foreign vessels	5.0 calls	2.18 days	10.90 days
MV Nivaga II	2.2 calls	4 .14 days	9.02 days
MV Manu Folau	3.8 calls	5.53 days	21.01 days
Total Length of Stay per Month			40.93 days

The total number of mooring days of international vessels and inter-island vessels combined at Funafuti Port is 40.93 per month. Accordingly, the necessary number of berths can be derived as two, based on the following equation.

40.93 vessels ÷ 30 days = 1.36, to be rounded up to 2

In addition, the number of port entries of inter-island vessels in 2006 was recorded as 35 for Nivaga II and 43 for Manu Folau. Of these, on 26 occasions, or for 114 days, the two vessels were mooring concurrently. It is obvious that it is difficult, in terms of operation, to maintain the convenience of the port with only one berth. From the standpoint of securing the safety of passengers while they get on and off and also the safety and efficiency of cargo handling work, it is deemed as appropriate to plan two berths for the new jetty, similarly to the existing jetty.

Since Te Mataili is usually stationed at Funafuti Port on standby for an emergency, it is deemed as necessary to allocate a dedicated berth for the ship as has been customary in the past. As Manaui uses the jetty for landing its fish catch, replenishing goods, and resting, a berth equipped with a landing area and a staircase for small-size boats will be provided.

(2) Structure of the jetty

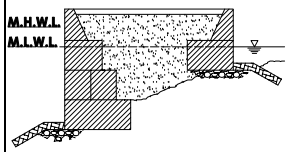
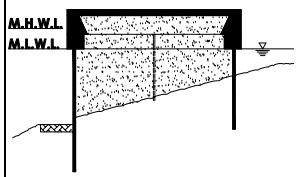
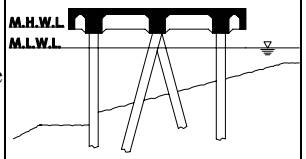
1) Jetty structure type

The basic structure of mooring facilities can generally be categorized into (i) gravity type, (ii) sheet-pile type, (iii) pile type, and (iv) floating type. The structure type for the new jetty shall be determined based on a comprehensive evaluation of a comparison study on the natural conditions, conditions for use, and construction conditions, with consideration given to the implementation schedule, construction costs, etc.

A floating-type jetty is, in general, a system suitable for places where the tide level greatly fluctuates and it is far below the surface of the water. It is advantageous in that installation and relocation are fairly easy, while it is disadvantageous in that it is vulnerable to the impact force and tractional force of vessels and also the load carrying capacity is small. It is less convenient as a jetty in terms of mooring, landing, and unloading as well as passing of transportation vehicles than the other three fixed types. Moreover, it requires a huge amount of maintenance costs after construction. Therefore, the floating type was excluded from the comparison study.

Table 2-4 compares the rest of the jetty types.

Table 2-4 : Comparison of jetty structure types

Type	Schematic drawing	Natural conditions			Conditions for use			Conditions for construction		
		Measures for the current ground	Measures for the front water depth	Safety level against impact of vessels	Ease of cargo handling	Quietness of backland	Major construction materials	Construction materials to be procured from outside the country	Major temporary works	Major construction works and technologies
(i) Gravity type		Generally speaking, it is suitable for a hard, gravel layer. Depending on the conditions of the sand stratum at the construction site, it is necessary to examine the depth of the rubble mound.	It is not appropriate with a deep water depth.	Most resistant to impact of vessels	All are favorable.	Serves as a wave absorbing dyke, and hence improves the quietness of the backland.	Though it requires a large-scale rubble mound for constructing the foundation underneath the concrete blocks, there is no stone pit around the project site.	A large-size heavy machine will be needed for installing concrete blocks.	A manufacturing yard for concrete blocks will be needed near the project site.	Since the project involves substantial underwater works for installation of rubble mound foundation and blocks, skilled workers will be needed. As the concrete-related works will be performed on land, it is the easiest approach of the three options.
(ii) Sheet-pile type		It is suitable for the sand stratum, but if the layer contains boulders, it is necessary to consider concurrent use of the water-jet method, etc. for piling sheet piles.		Relatively resistant to impact of vessels, and energy absorption is large.			Sheet piles will have to be imported from Japan.	A crane, vibratory hammer, and generator will have to be procured for installing sheet piles.	Simple scaffolding will be necessary.	The most simple of the three options.
(iii) Pile type		The pile-type method needs a similar kind of examination to the sheet-pile type.	It is feasible at a significant water depth.	Resistant to impact of vessels, but rather unstable.		Not as effective as the previous two types in terms of improving the quietness of the backland.	Steel-pipe piles and materials for the temporary stage will have to be shipped from Japan.	A piling vessel will need to be procured.	A large-scale temporary stage will be needed for concrete works for beams and floors.	Skilled workers will be needed, since it is a technically high standard approach which involves substantial underwater operations for piling and concrete works. It is the same method used as for the existing jetty.

2) Structure of the jetty

Since the jetty construction site is situated at a deepwater point and it is difficult to procure stones for construction in large quantities in the country, the gravity-type structure is less economical and feasible. Non-gravity-type structures are the pile type (the jetty type and the double sheet pile wall type) and the floating type, the latter of which requires a large vessel to transport it from the production yard to the site and large-scale construction work for its installation. Therefore, it is difficult to adopt the floating type. Of the two pile-type structures, the double wall type requires filling materials, such as sand, therefore, similarly to the gravity type, it will be difficult to procure the necessary materials.

Consequently, it is deemed as most practical to adopt the same steel pile jetty structure as the existing jetty for the new jetty. The basic structural cross-section of the jetty shall be determined by comparing how to combine piles and the length of spans. The pile-type jetty shall be designed in the following order as shown in Fig. 2-4.

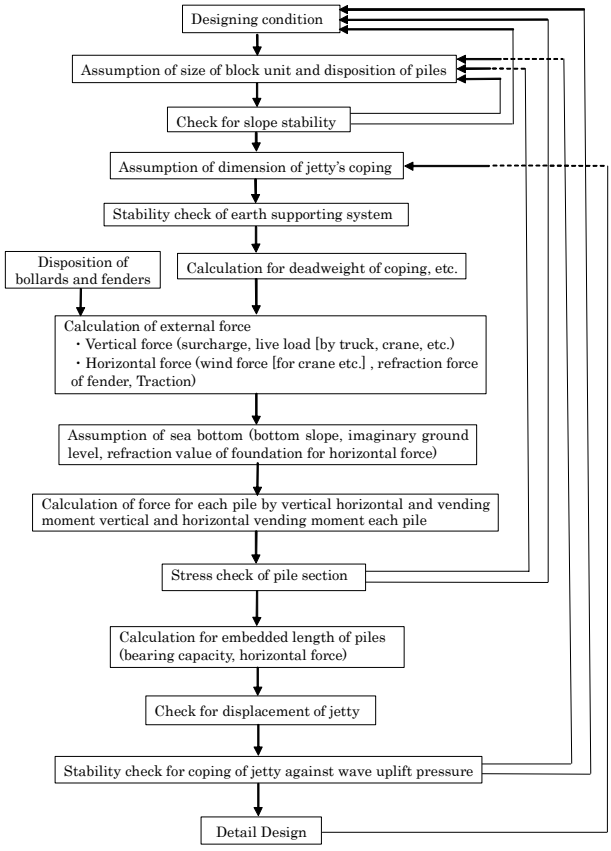


Fig. 2-4： Design flow for a pile-type jetty

There are two types of sectional forms of a jetty: inclined-pile type and vertical pile pier type. The inclined-pile type is usually employed as the sectional form against external horizontal forces such as berthing and tractional forces. However, in order to construct an inclined-pile jetty, enormous costs will be incurred for procuring a ship with the pile hammer from a distant location, making cost-effectiveness low. Thus, it is difficult to adopt this method in this project. For this reason, the vertical pile pier type

has been adopted as the structure of the jetty to be constructed under the project, which allows construction from a barge.

In view of the live load of the foreign cargo vessels (with a displacement tonnage of approximately 3,000 tons) that will use the new jetty and cargo handling work on the jetty, the schematic section of the jetty shall be as in Fig. 2-5.

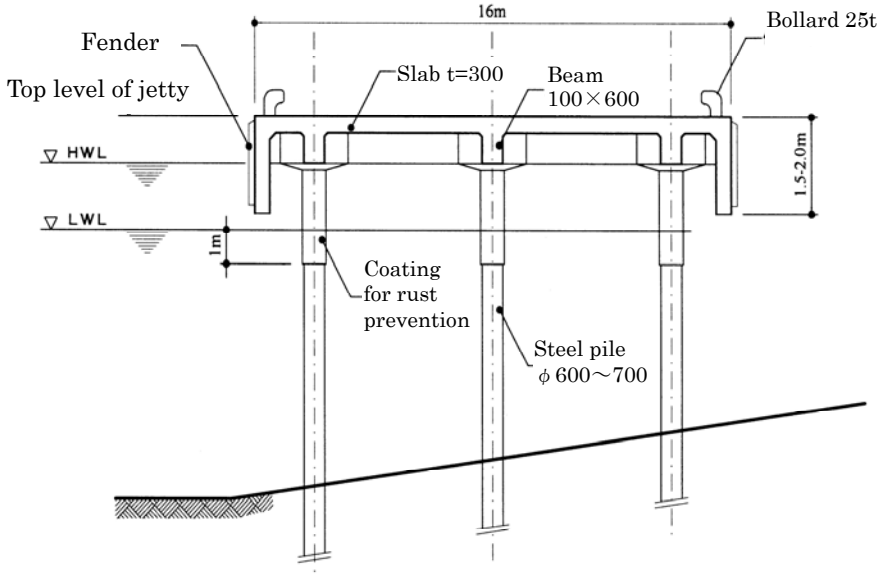


Fig. 2-5 : Schematic section of the pile-type jetty

As a result of an examination of the rust prevention method for each vertical section of the piles based on maintenance, workability, and reliability, a rust margin for an erosion speed of 0.1mm/year shall be taken into consideration for the main part of the steel pipe piles, and a coating for rust prevention, which is easy to manage and highly reliable, shall be applied to the structures above LWL -1.0m where salt water and air concurrently exist to accelerate the progress of rusting (See Fig. 2-6).

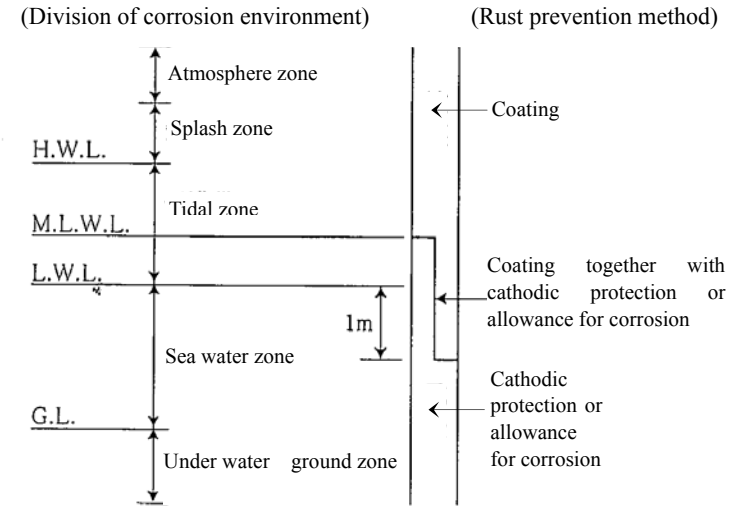


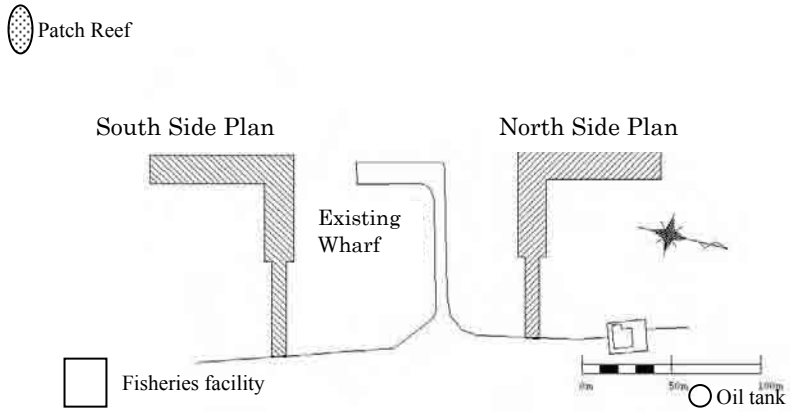
Fig. 2-6 : Corrosion environment and respective anti-corrosive methods (coating and cathodic protection)

(3) Location of the jetty

Two approaches were studied as to the location of the jetty in the same premises: one being on the north side of the existing jetty and the other on the south side, by comparing various conditions as shown in Table 2-5.

As a result of an overall evaluation, the south side was finally selected for the following reasons: the transportation distance from the jetty to the container yard would be shorter, making the work more efficient; the premises can be expanded: it is closer to the fisheries facility; it is safer, keeping a certain distance from the storage facility for hazardous substances; and the patch reef problem can more easily be mitigated by putting up navigation aids, as well as various other reasons.

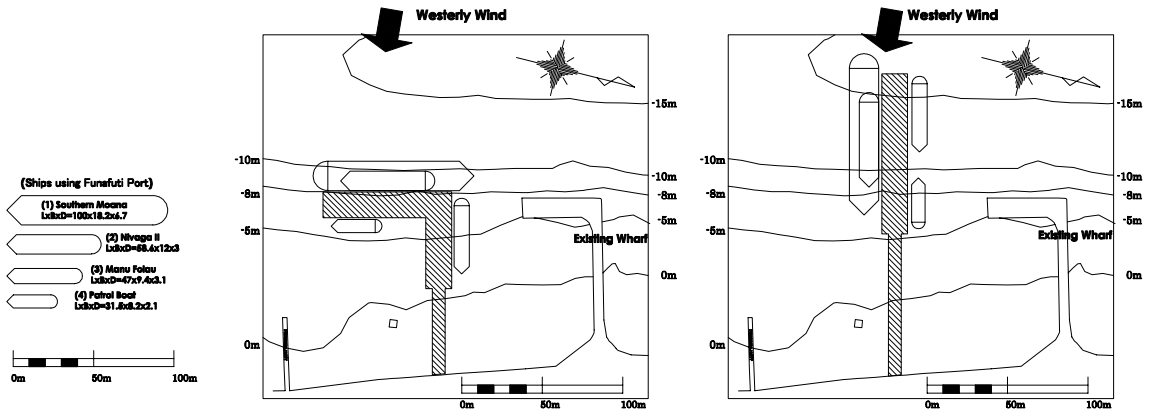
Table 2-5： Comparison of the candidate locations of the jetty

Evaluation item		South side	North side
Proposed layout			
1. Convenience	・Maneuverability ・Land use ・Operation of the facilities	・Closer to the patch reef in the south, and hence the approach lane will be restricted. ・It is possible to expand the site to the southward. ・The transportation distance from the jetty to the container yard is shorter. More efficient work can be expected. ・It is advantageous for landing and other works since it is closer to the existing fisheries facility.	・When fueling a tanker, it will overlap with the work sea area, and therefore, the approach lane will be restricted. ・It is difficult to expand the premises to northward. ・The transportation distance will remain the same, while the oil tank will be still close. Thus, it is necessary to take risk avoidance measures. ・It will be farther from the fisheries facility.
2. Safety	・Quietness within the port ・ Response to emergency	・It is necessary to implement countermeasures against west winds when approaching and leaving the jetty. ・No particular problem	・Same as left ・It is necessary to pay particular attention to possible accidents of the storage of hazardous materials （oil tank）.
3. Economy	・Total construction cost	・No driver to increase the cost	・Same as left
4. Elasticity of the project	・ Response to change in the surrounding conditions ・Developability	・Possible ・No obstacle to use of the premises and it is easy to expand the premises	・Same as left ・The use of the premises in a northerly direction is limited.
5. Environmental conservation	・Response to the social environment ・Response to the natural environment.	・There are no facilities to be taken into consideration, such as general residences, schools, hospitals, etc. Thus the impact is deemed as minimal. ・It is a construction project using the same structure in the same premises as the existing jetty. Thus, except for the construction period, the impact is deemed as minimal.	・Although there are no facilities to be taken into consideration, such as general residences, schools, hospitals, etc., it is necessary to pay attention to the dangerous material storage facility nearby. ・Same as left
Overall evaluation		・Excellent land use and social environment ・ Beacons or other measures must be implemented as a safeguard for the patch on the ship course.	・ No obstacle to the ship course and the maneuverability is high. ・Limitation to the use of the premises. Consideration needs to be given to the dangerous material storage facility.

(4) Shape of the jetty

The field survey concluded that two options, L-shaped and I-shaped jetties, were subject to further examination as to the shape of the jetty. Various conditions associated with the shapes were compared as shown in Table 2-6.

Table 2-6 : Comparison of shapes of the jetty

Evaluation item		L-shaped jetty	I-shaped jetty
			
1. Convenience	・Maneuverability	・A vessel has to approach the jetty via a detour.	・Linear approach is possible.
	・Workability	・A containership can approach at the center of the jetty. ・Efficient work is possible.	・The bow of the ship largely protrudes while berthing, hence restricting the work position.
	・Management of the facility	・It is possible to store empty containers at the end of the jetty for preparation, contributing to the time efficiency.	・Storing empty containers at the end of the jetty for preparation is not possible.
2. Safety	・Response to strong winds from the west	・Since the jetty has a normal berthing line in a north-south direction, the impact of strong west winds in a perpendicular direction will be significant.	・Since the jetty has a normal berthing line in a west-east direction, the impact of strong winds prevailing from the west will be comparatively low.
	・Water depth for approaching the jetty	・Except containerships, ships can choose the berth of north-south or west-east. ・It is possible to secure a water depth of 8-10m.	・A depth of 5m-19m, of the slope of the seabed, can be secured on both sides of the jetty.
3. Economy	・Construction cost	・No factors to increase the cost	・A water depth of 17-19m at the end will push up the cost.
4. Elasticity of the project	・Response to change in the surrounding conditions	・It is difficult to meet further requests for more water depth.	・It is possible since a water depth of 17-19m is already assured.
	・Developability	・It can accommodate further expansion.	・Same as left
5. Environmental conservation	・Response to the social environment	・It is a pier-type jetty, so it has a minimal impact on the social environment.	・Same as left
	・Response to the natural environment.	・It is the same pile-type jetty as the existing jetty, having a minimal impact on the natural environment, except for the construction period.	・Same as left
Overall evaluation		Although improvement of the work efficiency can be expected, it is not possible to respond to further increase in the water depth. There is no driver to increase the construction cost.	Although it allows a large vessel with a deep draught to approach, the workability is not favorable, and also the fact of being a deep jetty will push up the construction cost.

According to the results of the above comparison study, it was deemed that an L-shaped jetty is more favorable in terms of work efficiency as well as economy, which is to say that it is less expensive to

construct a jetty of the same length or it will be a longer jetty if the same amount of construction cost is procured.

In addition, the normal line of the main berth of an L-shaped jetty will be in a north-south direction; this is no problem and it is easier for vessels to leave the berth as they are subject to winds from the east that prevail throughout the year in a direction perpendicular to the jetty. On the other hand, it is disadvantageous to be subject to strong winds from west that can be accompanied by cyclones, etc. Nevertheless, under such abnormal weather conditions, the wave heights at the port will easily exceed 50cm, the allowable wave height for working operations, and therefore cargo handling work will have to be stopped in any case regardless of the direction of the jetty; therefore, west winds will not be the only element working to the detriment of the facility.

However, if a vessel mooring at the main berth is hit by a strong wind from the west, the belly of the ship will bang the jetty, causing impact or, in the worst case, damage to both the ship and the jetty. For this reason, it is important to install closely-studied fenders and also take precautions on the port facility side, such as putting mooring buoys offshore on the west side, in order to create a highly-convenient environment.

The necessary number of berths is planned as two for foreign vessels and inter-island vessels, one for Te Mataili, and one for other small fishing boats. The layout of these berths on the jetty is given in Fig. 2-7.

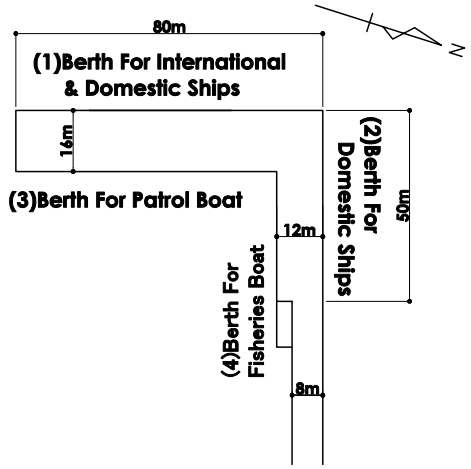


Fig. 2-7 : Layout of berths

(5) Extension of the jetty

The current 50m-long berth only allows routine containerships Southern Moana and Nivaga II to partially moor, with their ends protruding from the jetty, and forces them to extend their mooring lines from the bow and the stern to the mooring dolphins away from the jetty to be berthed. When these vessels are approaching the jetty, the mooring lines from the bow and the stern disturb all the other berths of the jetty, the ship course of the fisheries jetty and the slipway. As a result, on average, it disables the approach to the fisheries facility from offshore for one to two days in the case of Southern Moana and for 4.14 days in the case of Nivaga II. In addition, the number of port calls by Nivaga II between 2004 and

2006 was 2.2/month. Taking the average number of mooring days at a time, 4.14, the ship virtually blocks the berth for about 9.1 days/month. In case of Southern Moana and other container vessels, the number of port calls per month is 1.1, and the average number of mooring days at a time is approximately 2.2, therefore occupying the berth for approximately 2.2 days/month. Therefore, the approach is disabled, on average, for 11.3 days per month in total.

An extension of the jetty shall be planned so that Nivaga II, with its long mooring time at the jetty, will be able to berth safely, making use only of the bollards and not the the mooring dolphins, thereby cutting the number of days where the approach is disabled and leaving the jetty open to other vessels.

<Statistics for Nivaga II >

- Length = 58.6m L　　Breadth = 12.0m B
- Angle of the mooring lines from the bow and the stern = 30°
- Necessary length of extension = 58.6 + (12.0 / 2 × 1/tan30°) × 2= 79.38 → 80.0m

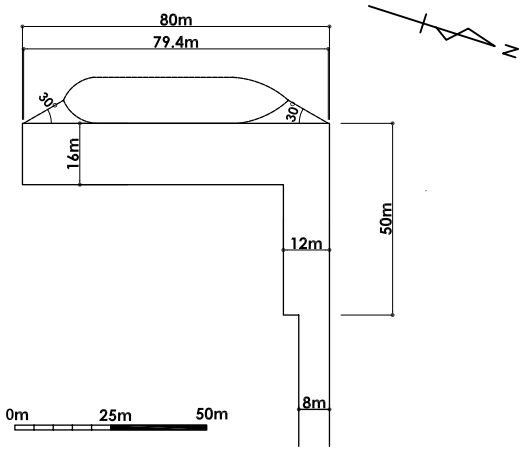


Fig. 2-8： Calculation of the extended berth length (Target vessel: Nivaga II)

The position of the edge of the jetty needs to be planned so as to assure the water depth is adequate for the main berth and the turning basin for Te Mataili that will use the berth on the east side （close to the shore. The adequate water depth for Te Mataili to conduct safe operations is approximately 3m. At the time of the lowest tide, an area of water up to 70 m from the shore becomes shallower than this, restricting the ship from operating. On the other hand, at a time of high tides, the turning basin (at least twice the ship length for the rotation diameter) can be assured by keeping a distance of approximately 100 m between the shore and the berth. The normal line of the berth of the existing jetty on the shore side lies approximately 100 m away from the land. Therefore, by setting the normal line of the new jetty on the shore side at the same as that of the existing jetty, the same level of convenience shall be attained.

As a result of the above study, the necessary length of the extension for access that connects the shore and the jetty, including the berth for inter-island vessels, shall be set as approximately 100 m, the same as the access of the existing jetty.

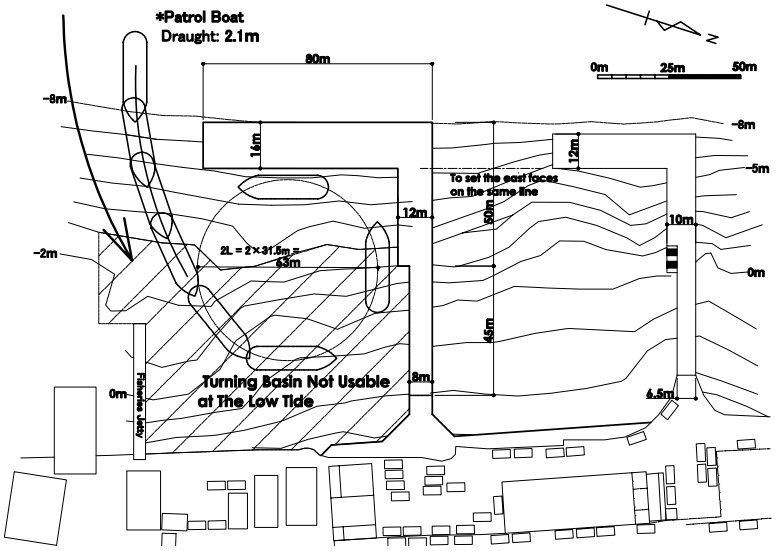


Fig. 2-9： Turning basin of Te Matailli

(6) Width of the jetty

The width of the existing jetty is 12 m for the parallel normal line at the tip of the jetty, and 10 m and 6.5 m for the section with the vertical normal lines. The necessary width for the new jetty, however, shall be studied with due consideration given to smoother work when a large cargo vessel berths at the jetty, securement of spaces for temporarily placing empty containers to shorten the work time and rotating transportation vehicles, and the width for two-way traffic.

a) Necessary width of the main berth

The width of the main berth at the end of the jetty, where large containerships will mainly moor, shall be calculated based on the minimum rotation radius (R = 5.3 m) of the tractor (2.72 m B × 4.4 m L × 2.9 m H, 132 horsepower) that can pull a full trailer loaded with a 20-foot container (2.5 m B × 6.0 m L × 2.6 m H), the width of the full trailer, and the width for installing car stoppers and bollards, which is 1.30m.

Necessary width = 5.3 m × 2 + 2.50 m ÷ 2 × 2＋1.30 × 2 = 15.70 m

If taking the rotation width for an administrative vehicle and an ambulance into consideration,

Necessary width = 4.9 m × 2 + 1.3 × 2 = 12.40 m.

Based on the above, the width should be 15.70m > 12.40m, and the minimum necessary width shall be 16.00 m to satisfy both the conditions.

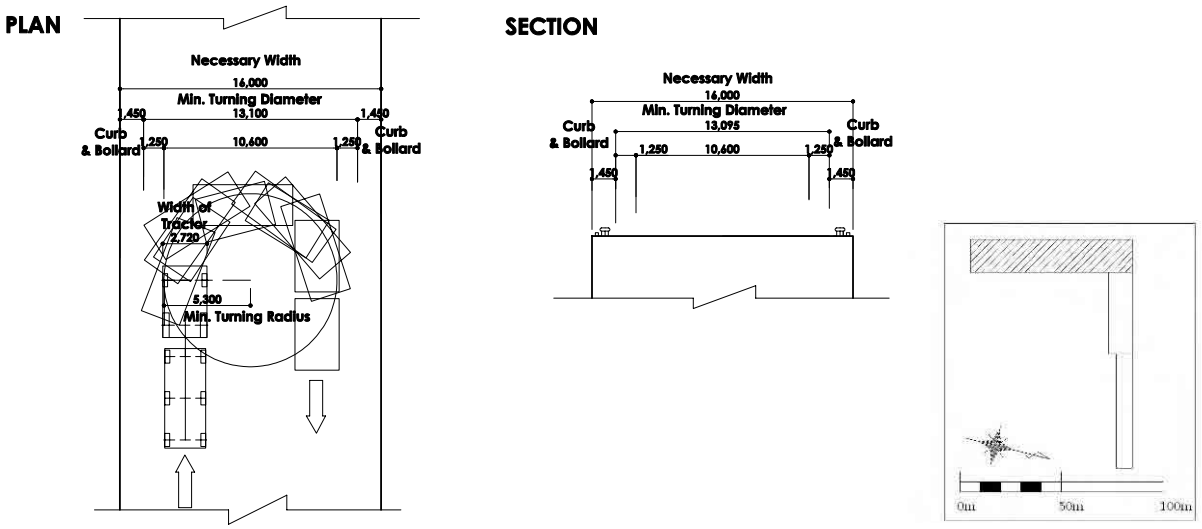


Fig. 2-10： Necessary width of the main berth （at the end of the jetty）
（in the case of a 20-foot container tractor）

b) Necessary width of the end of the access

The width of the end of the access (i.e., the berth for inter-island vessels and other small fishing boats) shall be planned as to allow a 2.5-ton forklift (B = 3.00 m) and a 20-foot container tractor (B = 2.50 m) to pass each other, and is calculated as 12.0m, based on widths of 1.0 m for workers' passage on the north side, 3.00 m for placing loading/unloading materials and equipment on the north side, and 0.75 m for installing car stoppers and bollards on both sides.

Necessary width = 3.00m + 2.50m + 1.00m + 3.00m + 1.00m + 0.75m × 2 = 12.0m

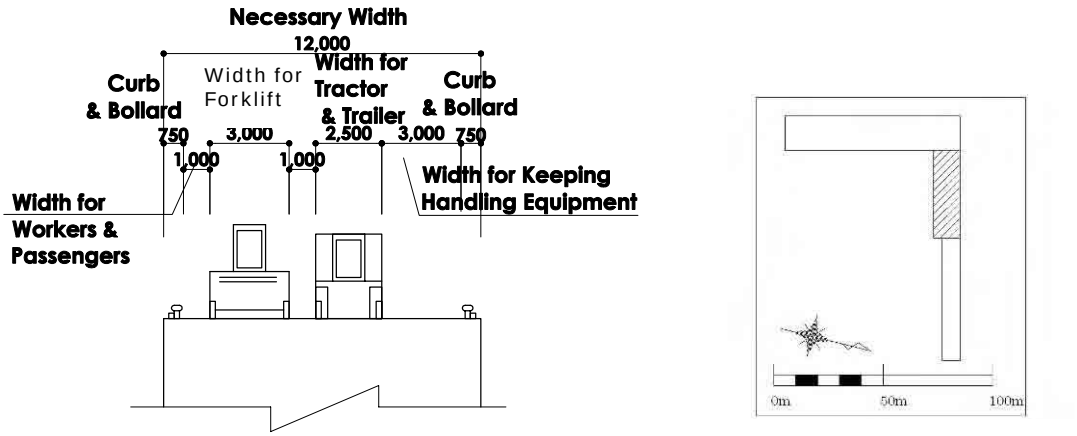


Fig. 2-11： Sketch showing estimated widths of the access

c) Access road

The width of the access road shall be calculated so as to allow the 2.5-ton forklift (B=3.00m) and the 20-foot container tractor (B=2.50m) to pass each other and 0.75 m each on both sides for installing crash

barriers.

Necessary width = 3.0m + 2.50m + 0.75m × 2 + 1.00 = 8.0m → Adopted

Thus, 8.0m shall be selected.

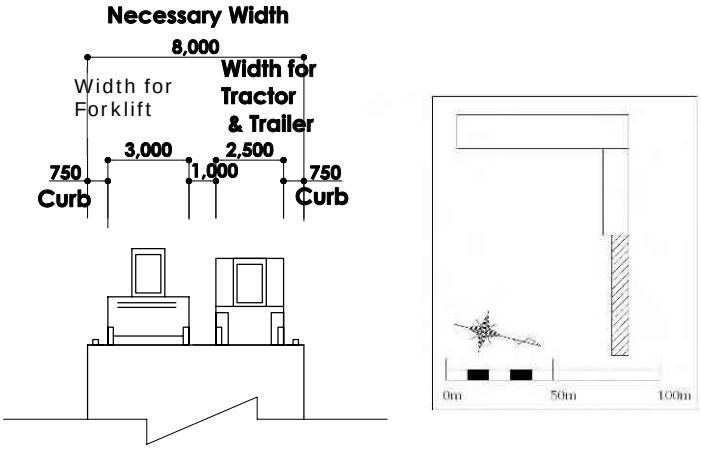


Fig. 2-12： Calculation of the width of the access road

(7) Depth of the jetty and the crown height

The depth of the existing jetty is as shown in Fig. 2-13 below.

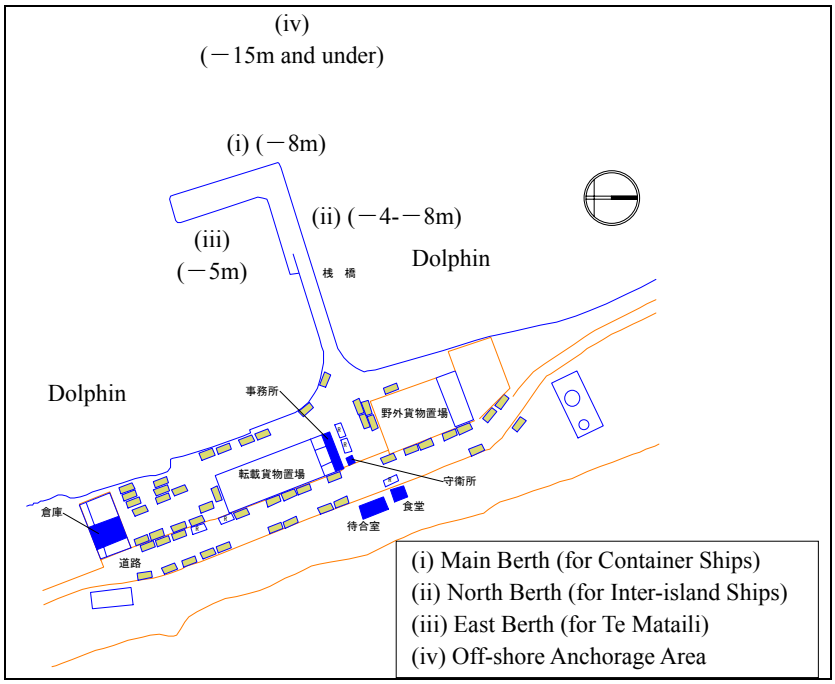


Fig. 2-13： Depths of the current berths

Of the domestic cargo passenger ships that Tuvalu possesses, Nivaga II has the greatest draught of 4.0 m, and there is no problem for this vessel to approach the jetty at present.

Table 2-7： Specifications of vessels calling at Funafuti Port

Name of Vessel	Type of Vessel	Registry	Overall Length	Breadth	Full Load Draught
MV Southern Moana	Container	Italy	100.0 m	18.2 m	6.7 m
Kyowa Cattleya	Container	Panama	117.5 m	20.2 m	7.4 m
MV Nivaga II	Cargo/Passenger	Tuvalu	58.6 m	12.0 m	4.0 m
MV Manu Folau	Cargo/Passenger	Tuvalu	47.0 m	9.4 m	3.1 m
Manaui	Fisheries Support Vessel	Tuvalu	18.4 m	4.8 m	1.5 m
Te Mataili	Naval Ship	Tuvalu	31.5 m	8.2 m	2.1 m

Of the vessels regularly entering Funafuti Port, Southern Moana (4,410 GRT, length overall = 100m) requires the greatest water depth, with its draught being 6.7m. It was confirmed in an interview with the ship's captain that the present water depth is not a particular problem, although it frequently uprolls the bottom sand when approaching and leaving the existing jetty. However, when the new jetty is built 115 m to the south, there is a patch reef on the ship's entry course, further limiting the ship course. It was confirmed, however, that it would not become a major obstacle if an adequate countermeasure, such as the setting up of navigation aids, its removal with explosives, etc. was taken.

The water depth shall be planned, in principle, targeting the vessels that currently use the jetty. However, since the jetty will run 4 m farther into the sea, the depth to be planned must be approximately -8 m considering the seabed topography. The crown height shall basically be planned as +4.6m, about the same as the height of the existing structure, considering that the current height does not impose any hurdle in using the jetty. Further, the crown height of the seawall shall be planned as high enough to accommodate the allowable overtopping rate (the allowable volume of seawater entering over the seawall into the island and flowing on the land) and the height of overtopping waves.

Examining the changes of the water depths at ports and harbors of Oceanian islands in the target area of the project for the past 20 years, it was found that the depth at refurbished ports and harbors has increased by 1.50m from 20 years ago. On average, it was -9.57m 20 years ago whereas it is -10.04m now, 0.47m deeper.

The planned water depth of -8m satisfies the requirements of the vessels currently using the jetty, and also it is deemed as sufficient and appropriate from the fact that the planned jetty is the only jetty in Funafuti but at the same time closely linked with the port conditions of the surrounding countries through licensed vessels.

Table 2-8： Transition of the water depths at the ports of neighboring countries

Name of Port	Water Depth 1984	Water Depth 2003	Change	Name of Liner
Betio, Kiribati	4.9 m	6.0 m	＋1.1 m	PFL
Nouméa, New Caledonia	7.5 m	10.3 m	＋2.8 m	PDL
Funafuti, Tuvalu	8.0 m	8.0 m	-	PDL
Apia, Samoa	9.4 m	10.0 m	＋0.6 m	-
Majuro, Marshall Islands	10.4 m	10.7 m*	－	PFL
Port Villa, Vanuatu	10.7 m	10.7 m	－	PDL
Pago Pago, American Samoa	11.0 m	11.0 m	－	-
Nuku'alofa, Tonga	12.0	11.7*	－	-
Suva, Fiji	12.2	12.0*	－	PDL/PFL
Mean Water Depth	9.57	10.04	＋1.50	

*As the port is not refurbished and the above figures are actual measurements, the water depth change is assumed as +0.
Source: Admiralty Sailing Directions Pacific I's pilot Volume II
PFL: Pacific Direct Line PFL: Pacific Forum line

(8) Redevelopment of the seawall and passages inside the premises

Since waves can overtop the existing seawall during stormy weather and accordingly seawater may enter into the premises, a seawall of approximately 103 m in length shall be provided to connect the access road of the new jetty and the existing jetty, thereby preventing seawater from entering. The normal line of the seawall shall be set approximately 2 m away in the west (17 m away from the existing warehouse), so as to secure an area 10 m wide for the transportation aisle and 6 m wide for the containers.

The following chart illustrates a rough layout and cross section of the seawall.

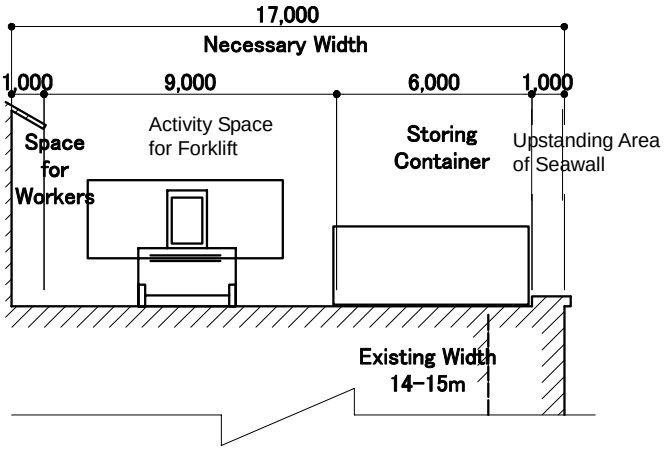


Fig. 2-14： Layout and cross section of the sea wall

(9) Facilities on the jetty

a) Electricity

In order to supply power to the vessels at the berths, power supply points shall be set up on the jetty.

There will be power enough for four vessels, namely, Nivaga II, Manu Folau, Manaui and Te Mataili. The power source and the capacity shall be planned to be 415/220V, 50Hz, 200kVA.

Electricity shall be branched from the distribution panel in the existing office of the Department of Marine and supplied to the two connection points to be prepared on the jetty. In addition, lighting facilities for night duty are also planned to be installed.

b) Water supply

As a water supply facility for vessels, two water supply points shall be set up on the jetty, covering the four vessels, Nivaga II, Manu Folau, Manaui and Te Mataili.

c) Incidental facilities

For the sake of efficient use and safety of the facilities on the jetty, the following incidental facilities shall be provided.

・Fenders	The V-400x1800L type for the main berth and the V-250x1800L type for the other berths.
・ Bollards	T-head bollard for the main berth and mooring posts for the other berths.
・ Crash barriers	Crash barriers shall be placed on the jetty in order to prevent accidents.
・ Mooring rings	Mooring rings shall be placed near the staircase of the jetty for small fishing boats.

d) Installation of navigation aids or removal of the patch reef

The field survey has identified a patch reef at -4.7m on the approaching ship course, which obstructs the approach of vessels. (See the following map). This patch reef impedes navigation of containerships, and hence needs to be indicated with a beacon so as to maintain the safety of the ship course. In principle, a radar reflector shall be installed as a beacon.

In addition, the test navigation conducted by the marine-related personnel on the Tuvaluan side on a later date found another shallow point. However, since it is as deep as -9.7m and unlikely to disturb sailing of the vessels to be covered in the project, the project shall not include any countermeasure for this point.

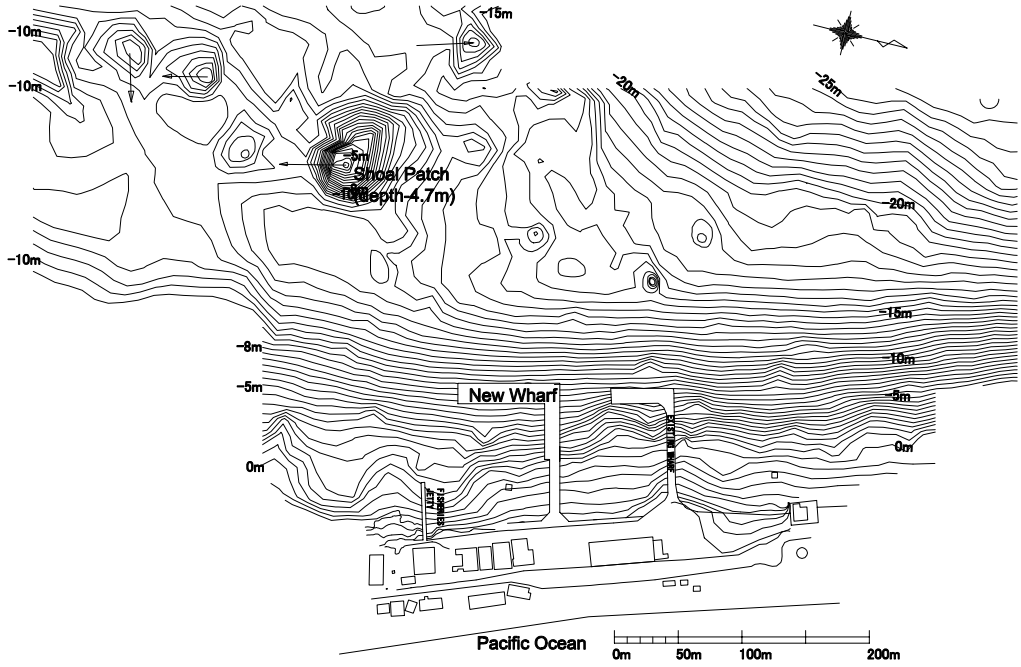


Fig. 2-15 : Locations of patch reefs on the ship course

(10) Structural planning

1) Standards to be observed

As there are no specific norms and standards for structural planning in Tuvalu, Australian standards are generally referred to in design. However, it is not mandatory to observe the standards but it is left to the responsibility of the main body of planning which norms and standards to adopt.

Comparing the design standards of Japan and Australia, they make no difference in design outcome provided that the external force, lifetime (50 years in both countries), and other design conditions are identical. Considering, in addition the ease of procuring steel materials and the workability, the fact that the project is to be implemented under Japan's grant-aid assistance scheme, and hence it is important for Japanese engineers to be well acquainted with the standards to be referred to, it is advantageous to make a design based on the Japanese standards. Accordingly, the project shall comply with the following standards, in principle, in designing the facilities to be provided under the project.

(i) "Technical Standards for Port and Harbor Facilities in Japan – 1999, Japan Port and Harbor Association"

(ii) "Port and Harbor Structure Design Samples, April 1999, Coastal Development Institute of Technology (CDIT)"

(iii) "Corrosion Prevention of Port and Harbor Steel Structures: Improvement Manual (Revised Edition), April 1997, Coastal Development Institute of Technology (CDIT)"

(iv) “Standard Method of Quantity Survey for Port and Harbor Works, FY2006 revision, Japan Port and Harbor Association”

(v) “Technical Manual for Prestressed Concrete-Type Piled Pier, October 2003, Coastal Development Institute of Technology (CDIT)”

(vi) “Jacket Method Technical Manual, January 2000, Coastal Development Institute of Technology (CDIT)”

(vii) “Specifications for Highway Bridges, Part IV Substructures, March 2002, Japan Road Association”

(viii) “Standard Specification for Concrete Structures-2002, Structural Performance Verification, Japan Society of Civil Engineers (JSCE)“

(ix) ”Engineering and Construction Method of Steel Pipe Pile - Japanese Association for Steel Pipe Pile (JASPP)”

2) Design conditions

Based on the results of the survey on the natural conditions, etc., the following design conditions shall be adopted in the project.

a) Oceanographic conditions

Designed standard sea-level	Designed standard value
Highest high water level (H.H.W.L.)	D.L. + 3.26 m
High water level (H.W.L).	D.L. + 2.99 m
Low water level (L.W.L.)	D.L. + 0.99 m
Crown height of existing wharf	+4.6 m
Plan crown height	+4.6 m
Significant wave height ($H_{1/3}$)	2.1 m
Maximum wave height (H_{max})	3.8 m

b) Soil conditions

As a result of the survey on the soil conditions, the following soil conditions shall be adopted.

Design water depth: -8.0m to -1.5m

Coral rock: 6.1-27.9MPa (16.5MPa on average)

c) Design seismic coefficient

Since there have been no earthquakes recorded in Tuvalu and any seismic forces are not considered in the structural calculation in architecture and civil engineering in the country, it shall not be taken into consideration in this project, too.

d) Vessels to be covered

4,410 GRT containership

Displacement tonnage:	3,000 tons
Displacement:	4,772 tons
Length overall:	100m
Moulded breadth:	18.2
Full load draught:	6.7m
Approaching velocity:	0.15m/sec
Approach angle:	0°-15°
Length between perpendiculars (LPP):	81.3m
Tractional force:	350kN

e) Live load conditions

Surcharge Jetty: 20kN/m^2

f) Wave force

Design wave height	$H_{1/3}$ = 2.1m	Period T = 5.6sec
Maximum wave height	Hmax =3.8m	Period T = 5.6sec

g) Conditions of main materials

(i) Steel materials

Material	Allowable unit stress (N/mm^2)
Steel pipe piles (SKK400, SKK490 or equivalent)	140 (SKK400), 185 (SKK490)
Steel bar (SD295A or equivalent)	176

(ii) Corrosion speed of steel bars

Corrosion environment		Corrosion speed (mm/year)
Area	Above H.W.L.	0.1
	Between H.W.L. and L.W.L. –1.0m	0.1
	Under L.W.L. –1.0m to sea bottom	0.05
	Below sea bottom	0.03

(iii) Concrete

Material	Unit weight	Allowable unit stress
Reinforced concrete	2.45 t/ m^3	24 N/mm^2
Plain concrete	2.30 t/ m^3	18 N/mm^2

2.2.2.2. Water tank

The existing water tank in the port area is installed next to the warehouse, with a capacity of 150m^3, made of concrete, and has a semi-subterranean structure. Rainwater collected on the roof of the warehouse is stored in the water tank until supplied to the vessels. Unfortunately, however, the tank is not functional as a

water supply system at all due to the degraded piping and the broken pump. As a result, the water generated by the desalination plant of the Public Works Division (PWD) is procured in order to supply vessels so they can depart the port with freshwater.

The volume of water purchased from the Public Works Division is given in the following table. The water is supplied by the PWD's water supply vehicle. It was revealed, in the course of discussion, that the requested scale of the water tank is 1,500m^3.

Table 2-9 : Volume of water purchased by vessels from the Public Works Division

Date	Name of Vessel	gallon	(m^3)
1/01/2006	Te Mataili	1,000	(4.546)
3/01/2006	MV Nivaga II	8,500	(38.641)
9/01/2006	MV Nivaga II	7,000	(31.822)
10/01/2006	MV Nivaga II	7,000	(31.822)
22/01/2006	MV Nivaga II	7,000	(31.822)
23/01/2006	MV Manu Folau	3,500	(15.911)
23/01/2006	MV Nivaga II	3,500	(15.911)
25/01/2006	MV Nivaga II	7,000	(31.822)
Amount (**January**)		**44,500**	**(202.297)**
6/02/2006	MV Manu Folau	3,500	(15.911)
8/02/2006	MV Nivaga II	10,500	(47.733)
9/02/2006	MV Nivaga II	2,000	(9.092)
15/02/2006	MV Nivaga II	10,500	(47.733)
16/02/2006	MV Nivaga II	3,500	(15.911)
23/02/2006	MV Manu Folau	3,500	(15.911)
26/02/2006	MV Nivaga II	14,000	(63.644)
27/02/2006	Te Mataili	1,200	(5.455)
Amount (**February**)		**48,700**	**(221.390)**
7/03/2006	MV Manu Folau	3,500	(15.911)
13/03/2006	MV Nivaga II	10,500	(47.733)
14/03/2006	Te Mataili	1,000	(4.546)
19/03/2006	MV Nivaga II	14,000	(63.644)
26/03/2006	MV Manu Folau	3,500	(15.911)
Amount (**March**)		**32,500**	**(147.745)**
3/04/2006	MV Manu Folau	3,500	(15.911)
19/04/2006	MV Manu Folau	3,500	(15.911)
19/04/2006	Te Mataili	1,000	(4.546)
Amount (**April**)		**8,000**	**(36.368)**
8/05/2006	Te Mataili	1,200	(5.455)
11/05/2006	MV Nivaga II	3,500	(15.911)
16/05/2006	MV Manu Folau	3,500	(15.911)
16/05/2006	MV Nivaga II	3,500	(15.911)
17/05/2006	MV Nivaga II	3,500	(15.911)
20/05/2006	Te Mataili	1,200	(5.455)
21/05/2006	MV Nivaga II	10,500	(47.733)
Amount (**May**)		**26,900**	**(122.287)**
2/06/2006	MV Nivaga II	3,500	(15.911)
3/06/2006	Te Mataili	1,200	(5.455)
3/06/2006	MV Nivaga II	10,500	(47.733)
10/06/2006	MV Nivaga II	10,500	(47.733)
12/06/2006	MV Nivaga II	7,000	(31.822)
16/06/2006	MV Nivaga II	7,000	(31.822)
17/06/2006	MV Nivaga II	7,000	(31.822)
29/06/2006	MV Manu Folau	10,500	(47.733)
Amount (**June**)		**57,200**	**(260.031)**
1/07/2006	MV Nivaga II	14,000	(63.644)
2/07/2006	MV Manu Folau	3,500	(15.911)
2/07/2006	MV Nivaga II	7,000	(31.822)
6/07/2006	MV Manu Folau	3,500	(15.911)
12/07/2006	MV Manu Folau	5,500	(25.003)
20/07/2006	MV Manu Folau	3,500	(15.911)
21/07/2006	Te Mataili	1,200	(5.455)
24/07/2006	MV Manu Folau	3,500	(15.911)
31/07/2006	MV Manu Folau	7,000	(31.822)
Amount (**July**)		**48,700**	**(221.390)**
1/08/2006	Te Mataili	1,500	(6.819)
5/08/2006	MV Manu Folau	3,500	(15.911)
6/08/2006	MV Nivaga II	7,000	(31.822)
7/08/2006	MV Nivaga II	14,000	(63.644)
12/08/2006	Te Mataili	1,200	(5.455)
23/08/2006	MV Manu Folau	3,500	(15.911)
26/08/2006	MV Manu Folau	3,500	(15.911)
Amount (**August**)		**34,200**	**(155.473)**
6/09/2006	MV Nivaga II	1,000	(4.546)
8/09/2006	MV Manu Folau	7,000	(31.822)
11/09/2006	MV Nivaga II	17,500	(79.555)
19/09/2006	MV Nivaga II	10,500	(47.733)
20/09/2006	MV Nivaga II	7,000	(31.822)
26/09/2006	MV Nivaga II	3,500	(15.911)
Amount (**September**)		**46,500**	**(211.389)**
4/10/2006	MV Nivaga II	17,500	(79.555)
13/10/2006	Te Mataili	1,200	(5.455)
23/10/2006	MV Manu Folau	10,000	(45.460)
28/10/2006	MV Nivaga II	7,000	(31.822)
30/10/2006	MV Manu Folau	3,500	(15.911)
Amount (**October**)		**39,200**	**(178.203)**
6/11/2006	MV Manu Folau	3,500	(15.911)
10/11/2006	Te Mataili	1,200	(5.455)
18/11/2006	MV Manu Folau	10,000	(45.460)
23/11/2006	MV Manu Folau	3,500	(15.911)
23/11/2006	MV Nivaga II	14,000	(63.644)
28/11/2006	MV Manu Folau	3,500	(15.911)
28/11/2006	Te Mataili	1,200	(5.455)
30/11/2006	MV Nivaga II	10,500	(47.733)
Amount (**November**)		**47,400**	**(215.480)**
	Maximum	57,200	(260.031)
	Minimum	8,000	(36.368)
	Mean	39,436	(179.278)
	Median	44,500	(202.297)

The vessels to be covered in the project for water supply are Nivaga II, Manu Folau, Te Mataili (the naval

ship) and Manaui owned by the Department of Fisheries. According to the data on the water purchased from the PWD, the necessary water volume of Nivaga II, Manu Folau and Te Mataili combined is 44,500 gallons (app. 202.3m^3)/month. Based on the fact that Manaui only sails out to sea a couple of times a month and its water tank size is only 1 m^3, the necessary water volume can be expected as 2 m^3 per month. Moreover, if 0.12m^3/person/day × 18 person × 20 days/month = 43.2m^3/month is taken as the necessary monthly volume for miscellaneous water to be used in the port area, the total water volume will amount to 247.5m^3/month, and hence it is appropriate to plan the water supply volume for the target vessels as 250m^3/month with some leeway included.

Table 2-10： Calculation of the necessary water volume

Targets for Water Supply	Application	Monthly Water Requirement
Nivaga II, Manu Folau, Te Mataili	Adopt median value from Table 2-8	202.3m^3
Manaui	1.0m^3 /trip x 2 trips	2.0m^3
Micellaneous	0.12m^3 x 18 persons x 20 days	43.2m^3
Total Water Requirement		247.5m^3 Say 250m^3

The annual average rainfall in Funafuti is about 3,500mm. The seasons are largely divided into the rainy season from December to the following March and the dry season from April to November. However, approximately once in every four years there is an average rainfall of less than 3,000mm, and a drought also occurs approximately once in every 10 years when the rainfall falls below 2,500mm. Thus, water shortages are a serious problem particularly in the dry season. Due to such meteorological conditions, the capacity of the water tank must be planned so as to assure, as much as is possible, an adequate water supply even in a year with rainfall below the average. For this project, studies for the size of the water tank were undertaken by taking the average precipitation of the fourteen years that had rainfall totals of less than 3,000mm between 1945 and 2005.

Table 2-11： Study of the water tank capacity based on the average monthly rainfall in the years with rainfall below 3,000 mm

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	249.1	444.8	246.9	236.7	162.9	192.1	175.1	40.7	47.1	59.9	144.2	615.0	2,614.5
1951	325.5	279.1	166.3	179.4	256.0	130.6	301.0	116.7	137.0	270.1	244.5	198.9	2,605.1
1956	217.7	380.8	198.1	92.8	158.7	265.1	262.4	98.6	147.6	243.9	345.0	548.6	2,959.3
1962	202.4	285.6	148.1	128.3	54.0	138.0	186.4	211.1	115.3	234.0	135.5	636.8	2,475.5
1963	276.9	161.7	244.3	259.0	144.9	303.2	248.9	319.6	244.7	59.7	214.7	201.4	2,679.0
1971	254.8	235.0	225.9	70.0	45.6	132.0	141.2	191.9	193.3	230.8	162.1	342.9	2,225.5
1974	584.7	108.0	276.3	147.7	84.7	112.7	146.1	124.4	96.7	109.2	416.6	574.3	2,781.4
1975	521.2	166.0	165.0	322.5	272.6	94.4	106.9	340.2	162.6	163.2	167.0	371.3	2,852.9
1976	351.6	176.0	312.8	179.2	169.6	138.4	140.5	179.3	101.9	191.6	50.5	495.2	2,486.6
1985	465.9	182.2	574.4	158.5	306.6	96.7	296.7	175.1	136.0	188.6	88.6	219.5	2,888.8
1989	428.7	264.4	282.9	232.1	248.0	107.4	145.0	214.6	215.2	143.1	312.0	342.8	2,936.2
1999	311.6	259.5	313.5	314.5	155.6	221.2	72.2	116.4	93.2	66.9	187.3	308.6	2,420.5
2001	294.8	257.9	177.4	243.4	157.0	216.3	205.6	176.0	181.6	206.7	249.7	314.8	2,681.2
2004	287.3	296.8	485.3	239.0	162.1	147.9	162.9	159.8	262.8	146.5	211.7	229.4	2,791.5
Mean Rainfall (mm)	340.9	249.8	272.7	200.2	169.9	164.0	185.1	176.0	152.5	165.3	209.2	385.7	2,671.3
Supply Vol. (m^3)	340.9	249.8	272.7	200.2	169.9	164.0	185.1	176.0	152.5	165.3	209.2	385.7	
Consumption (m^3)	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	
Balance (m^3)	90.9	-0.2	22.7	-49.8	-80.1	-86.0	-64.9	-74.0	-97.5	-84.7	-40.8	135.7	
Reserved Vol. (m^3)	577.8	577.6	577.8	528.0	447.9	361.9	297.0	223.0	125.5	40.8	0.0	135.7	

The rainwater catchment area shall be set at 1,000m^2 of the roof of the warehouse whereas the monthly water consumption is 250m^3. The balance of the consumption and the water supply by rainwater is, as shown in the table, negative between February and November, except for March. Therefore, in order to satisfy the water consumption in November, it is necessary to secure at least 577.8m^3 of water at the beginning of the period. Thus, it is necessary to plan the capacity of the water tank to be approximately 600 m^3.

In addition, the Public Works Division recommends that the water tank should be able to store at least three –months' worth of water in order to be ready for any serious water shortage at a time of drought. In this case, since the necessary monthly water volume is 250m^3, 250 m^3 × 3 months = 750m^3 is required as its capacity. However, it is deemed that combined use of the existing water tank, with a capacity of 150m^3, and the new one will be sufficient to satisfy the demand.

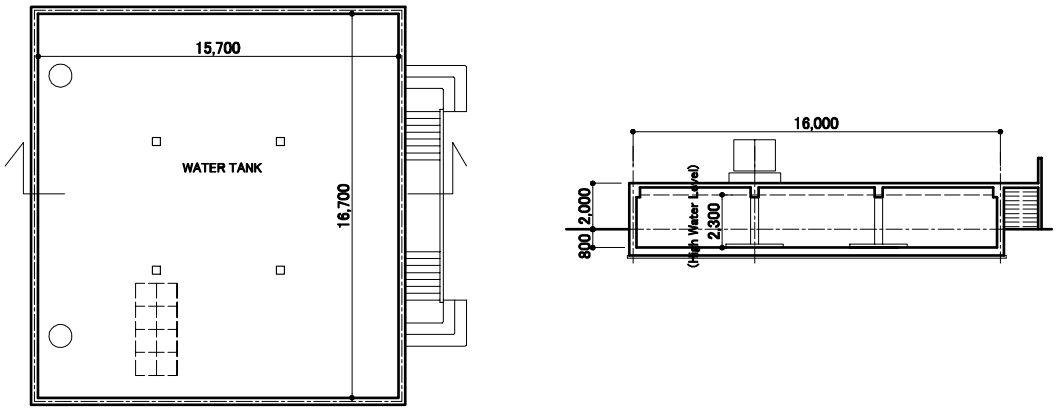


Fig. 2-16 : Water tank

2.2.2.3. Warehouse

The warehouse is not only used for customs clearance, inspection, and bonded storage of international cargos and temporary storage for domestic cargo to be shipped to outer islands, but is also multi-functional, serving as a workshop for the related equipment and storage of screws and other spare parts for the inter-island vessels.

The warehouse was originally constructed in 1980 as an incidental facility of the jetty at the port. It is a steel-frame one-story building with the roof and walls covered with aluminum sheets. The size of the structure is about 50m × 17.5m (875m^2). 25 years after construction, most parts of the building, except the foundations, are seriously deteriorated.

The aluminum sheets employed as exterior finishing materials have significantly corroded, causing water leakage. Other steel parts have already started to rust as well. The furring, the girders and a part of the column that is the main structure of the building are already damaged by rust to the extent that a partial loss of the area has been ascertained. Thus, in order to continuously use this facility, it is deemed as integral to urgently renovate the exterior finishing materials, revamp and reinforce the steel frames with paint, and repair the roller shutter, etc.

In the current situation where the roof of the warehouse, which is supposed to collect rainwater for the water tank, and eaves gutters and pipes for rainwater are not fully functional, it is difficult to expect rainwater collection. To this end, it is necessary to repair at least the eaves gutter together with the steel frames used for attaching it, pipes, and other related components.

2.2.2.4. Equipment plan

(1) Forklift

A large forklift is to be used in the container yard for unloading loaded containers from the trailer and placing them in predetermined locations. Although the maximum gross weight of a 20-foot container is slightly above 30 tons, it is not common, in general, that a loaded container will weigh about 25 tons, thus, the existing forklift with the deadweight tonnage of 25 tons functions without any problem. Thus, it is appropriate to plan for a 25-ton forklift in this project, too.

In the container yard, empty containers are stacked in three layers in order to save space in the narrow premises. However, loaded containers cannot be stacked on top of each other to allow for taking the cargo out of the containers. Because empty containers are lighter, the forklift carries two containers stacked vertically at a time and puts them together up onto the first layer of containers to make three layers. Thus, 3 m is usually sufficient as the lifting height of the forklift, and there are no other special specifications for the equipment. As such, it is appropriate to plan one forklift with the maximum loading capacity of 25 tons and the lifting height of 3 m in the project.

(2) Trailer and tractor

Containers are transported to the container yard by a trailer and a tractor after being transloaded from the vessel to the trailer using the crane. The average transportation time from the jetty to the container yard is approximately 15 minutes at present, provided that there is no failure of the equipment. This occupies a significant portion of the entire cargo handling time.

The project will shorten the distance from the jetty to the container yard by roughly 400 m in one round trip, whereby, together with the improvement of the container yard, it will improve the work efficiency. As a result, the time it takes to go and return is expected to be shortened to approximately 12 minutes. Thus, it takes about 10 hours to transport 50 20-foot containers.

On the other hand, sailing of containerships in the lagoon is obligated to be accompanied by a pilot onboard and also restricted to daytime when it is bright. Therefore, if a containership arrives at the port early in the morning, it has to stay at the jetty until the following morning unless it can depart the port before dark on the same day. If that is the case, even if cargo handling work becomes more efficient, it will not contribute to the reduction of the binding hours of containerships. That means, it is necessary to halve the round-trip time between the jetty and the container yard, which is a bottleneck at present, and, to do so, it will be necessary to have two sets of trailers and tractors in the future. Of these, the project will only cover one pair, with the expectation for the Tuvaluan side to procure the other pair on their self-help basis.

Based on the above, the contents of the project, aiming at retaining and improvement of the functions of Funafuti Port, are designed as follows.

Table 2-12： Contents of the project

Facility/equipment to be covered		Contents, scale, grade
Jetty	Jetty: L-shaped L.80.0m × W16.0 m＋ L.50.0m × W.12.0m Access road: L.51.5m × W8.0m, Quay for fishing boats: 1 set Development of the new seawall 103m Redevelopment of the container yard: 600m^2 Mooring dolphins: 2 places Navigation aids （for the offshore patch reef）: 1 set	The new jetty shall be constructed on the south side of the existing jetty, in an L-shaped structure, targeting the same vessels that use the existing jetty, on a scale optimal for achieving higher efficiency in cargo handling activities. The seawall shall be constructed as part of the container yard to establish access to the new jetty. To accommodate foreign containerships Navigation aids with radar reflector shall be set up to ensure safe navigation.
Port facility	Repair of the warehouse	To repair approximately 875 m^2 of the roof, walls, the eaves gutter, etc., of the warehouse. Anti-corrosive measures shall be taken by using aluminum or baking finished steel sheets.
	Water tank (600 m^3)	A concrete water tank with a capacity of 600 m^3 shall be set up next to the existing warehouse.
Equipment	Provision of cargo handling equipment Forklift (25 tons) Trailer and tractor	In place of the current degraded equipment, these new vehicles shall be provided with an aim to improve the efficiency of cargo handling activities.

2.2.2.5. Facility plan

(1) Electricity

Power in the port area is supplied from the 400kVA transformer installed in the premises of the Department of Fisheries. The transmission voltage of the buried cable is 11kV, which is stepped down to 415/240V, 50Hz by the transformer. The power distribution board is installed in the office of the Department of Marine.

Power supply to the jetty shall be branched from the receiving panel. The power trunk line shall be buried in the premises, and PVC conduit pipes will be used for connecting it to the jetty and other facilities.

The electricity system is composed of a lamp plug system and a power equipment system. The maximum load of the project equipment is calculated as follows:

Lighting and socket load	225 kVA
Power equipment load	38 kVA
Total	263 kVA

1) Lighting and sockets

As for lighting equipment, the project shall provide two lighting towers at the jetty for nighttime work, five lamps along the access road and the seawall, and indoor lighting for the warehouse. The lighting intensity of the planned facilities is set as follows (in accordance with the actual status in the country):

Work jetty	50 – 100 lux
Access bridge/seawall	10 lux
Warehouse	200 lux

As for power outlets, the project shall provide two plug points on the jetty for supplying power on the ground to the vessels that belong to Funafuti Port, and those for general use and for equipment and tools in the warehouse. The capacity and load voltage of each facility are as follows.

	Capacity	Voltage
Power supply for vessels	200 kVA	415/240V, 50Hz
General purpose power outlet	10 kVA	240V, 50 Hz
Power supply for machinery and equipment	15 kVA	415/240V, 50Hz
Total	225 kVA	

2) Power equipment

The project shall provide power equipment to cover the water pump and plugs for ten reefer containers in the container yard. The capacity and load voltage of each facility are as follows.

	Capacity	Voltage
Water pump	3 kVA	415/240V, 50Hz
Reefer container x 10 units	55 kVA	415/240V, 50Hz
Total	58 kVA	

3) Telephone

For telephone lines to connect the phone onboard the mooring vessel and the phone on the ground, PVC conduit pipes shall be laid on the jetty. The wiring work shall be carried out by Tuvalu Telecom.

(2) Water supply and wastewater facilities

Two approaches can be listed as methods to supply water: the direct supply method using a pump and the gravity method in which water is dropped from an elevated water tank by gravity. In this project, the gravity method shall be adopted, in light of the improbability of breakdown owing to its easy operability and the limited load to the pump. For this reason, the water supply system to be provided under the project shall include, in addition to the underwater pump to be installed in the water storage tank and the pipes, an elevated water tank.

The volume of water to be supplied to a vessel at one time is expected to be up to 80m^3 based on the purchase record of PWD (Table 2-9). It is appropriate to set the time taken for supplying water within about four hours, from the practical standpoint, and hence 20m^3 shall be planned as the supply volume per hour.

In addition, the existing water tank currently sends water to the toilets and shower rooms in the port office, however, there is no permanent pumping facility and the water is pumped up by an underwater pump. Considering the fact that there are no other toilets in the port area, the project shall cover the piping to the existing water tank, with the aim of improving convenience. As for wastewater, the existing facility shall continue to be used.

2.2.2.6. Construction material plan

In planning materials to be used for repairing the warehouse, the following points should be noted:

- The warehouse is situated in an oceanfront area where it is susceptible to salt damage.
- Construction materials shall all be imports from third-party countries.
- The schedule is a constraint.

(1) Roof and wall materials

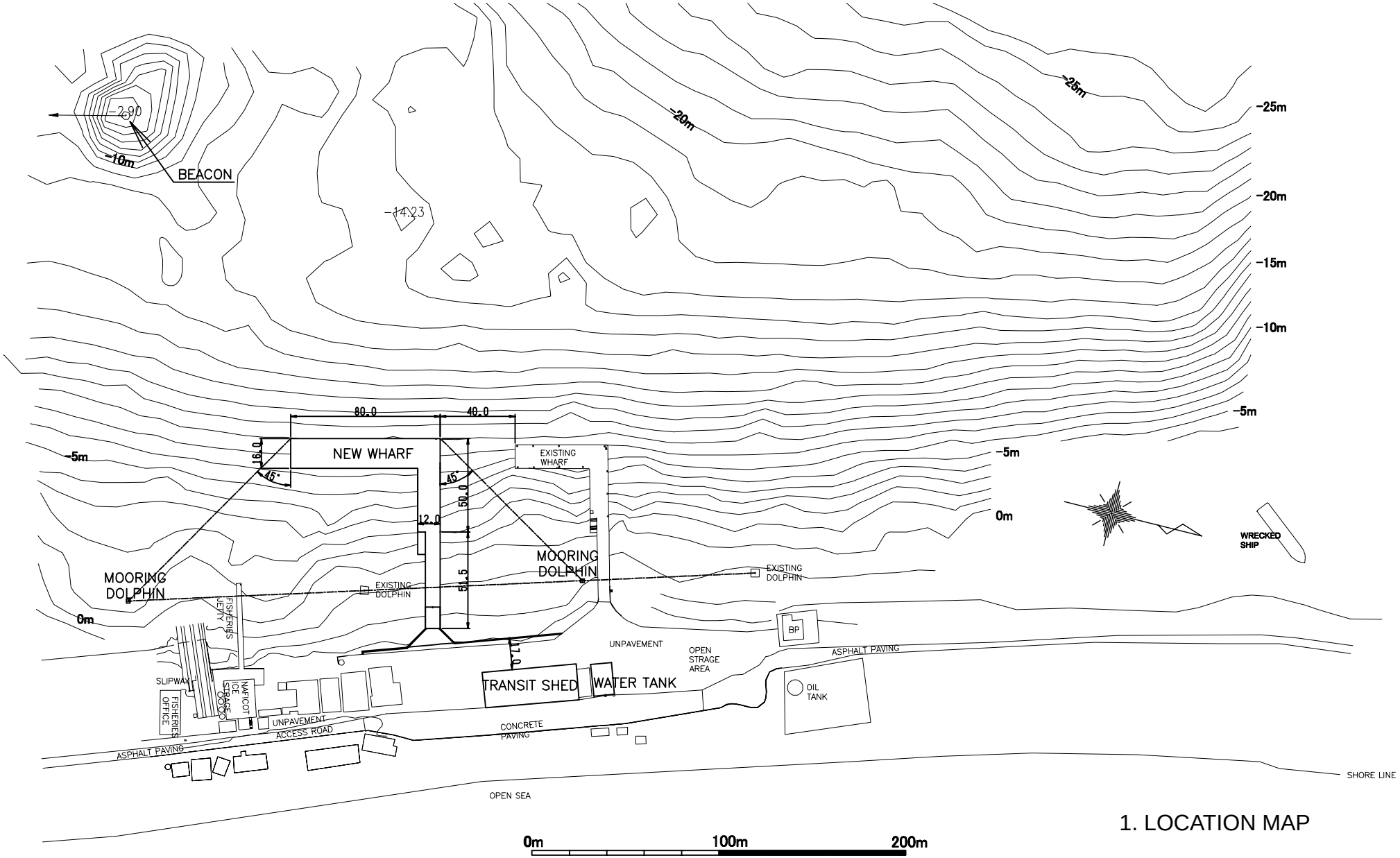
The existing warehouse uses aluminum sheets for its roofs and walls. As the materials to update these, either aluminum sheets that are commonly used in the country or steel sheets coated with anti-corrosive paint can be considered. In this project, aluminum sheets shall be adopted in light of their comparatively excellent durability.

(2) Opening

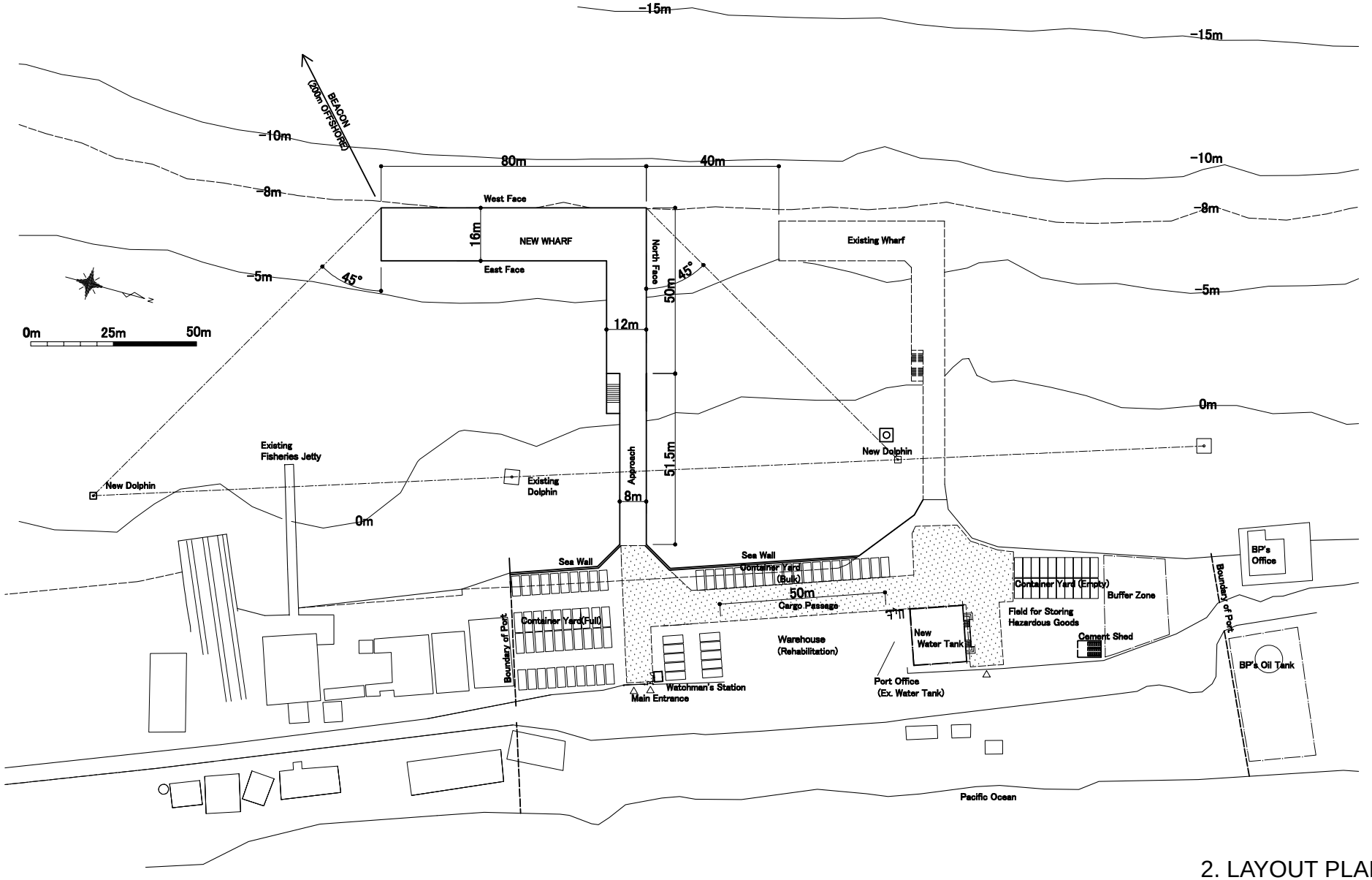
The openings of the existing warehouse are steel roller shutters, which, however, are severely degraded due to rust, and four out of the six openings can no longer open or close. Considering that the warehouse is located in a place where it is susceptible to salt damage, steel sliding doors shall be adopted since they are more resistant to rust than steel roller shutters and also easy to maintain.

2.2.3. Basic Design Drawing

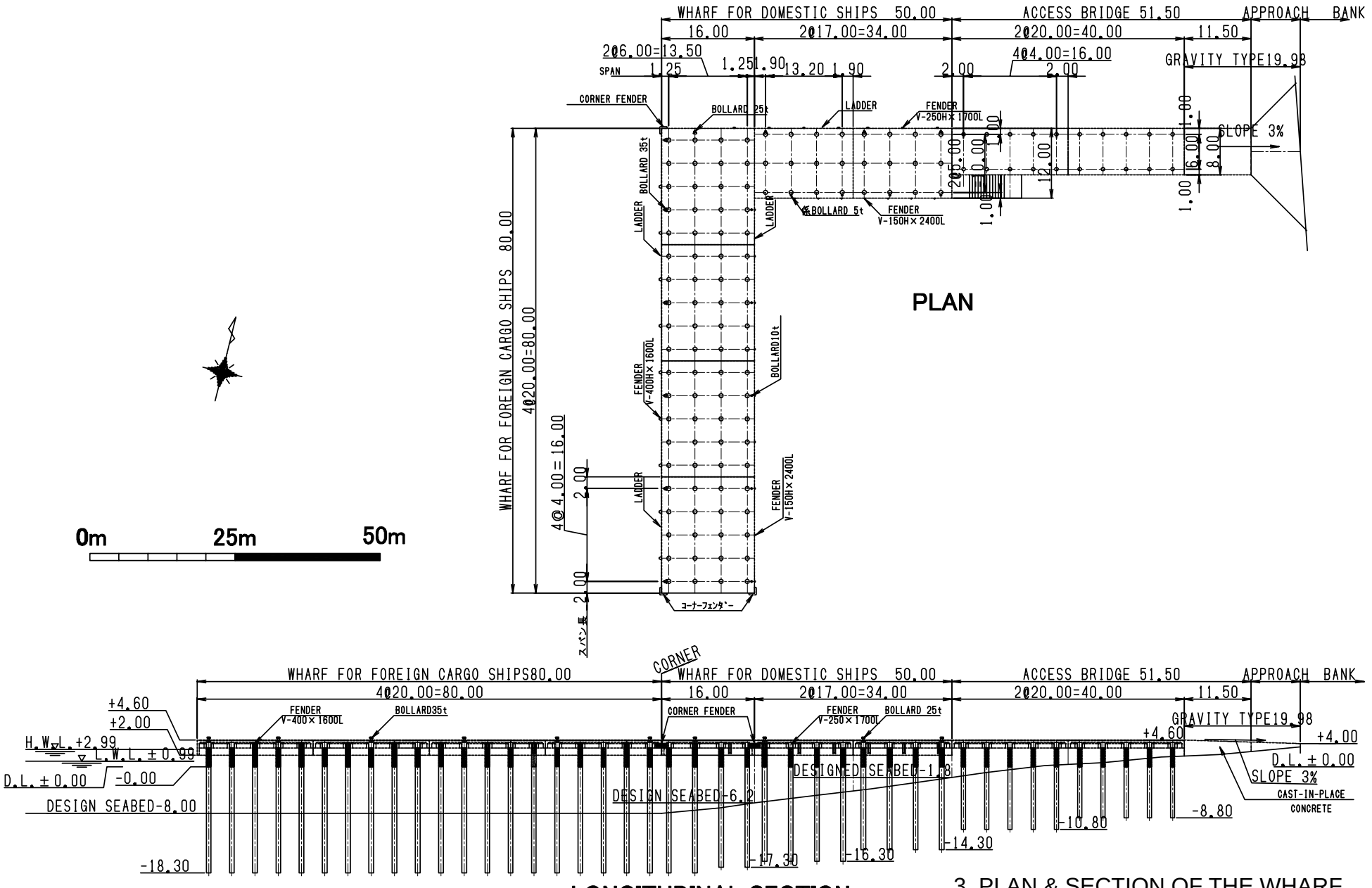
1. Location map
2. Layout of the facilities
3. Plane and cross-section views of the overall jetty
4. Plane and cross-section views of the jetty for foreign cargo vessels
5. Plane and cross-section views of the access of the jetty for inter-island vessels
6. Plane and cross-section views of the access road of the jetty
7. Plane and cross-section views of the staircase of the jetty
8. Plane, cross-section and elevation views of the warehouse and the water tank



1. LOCATION MAP



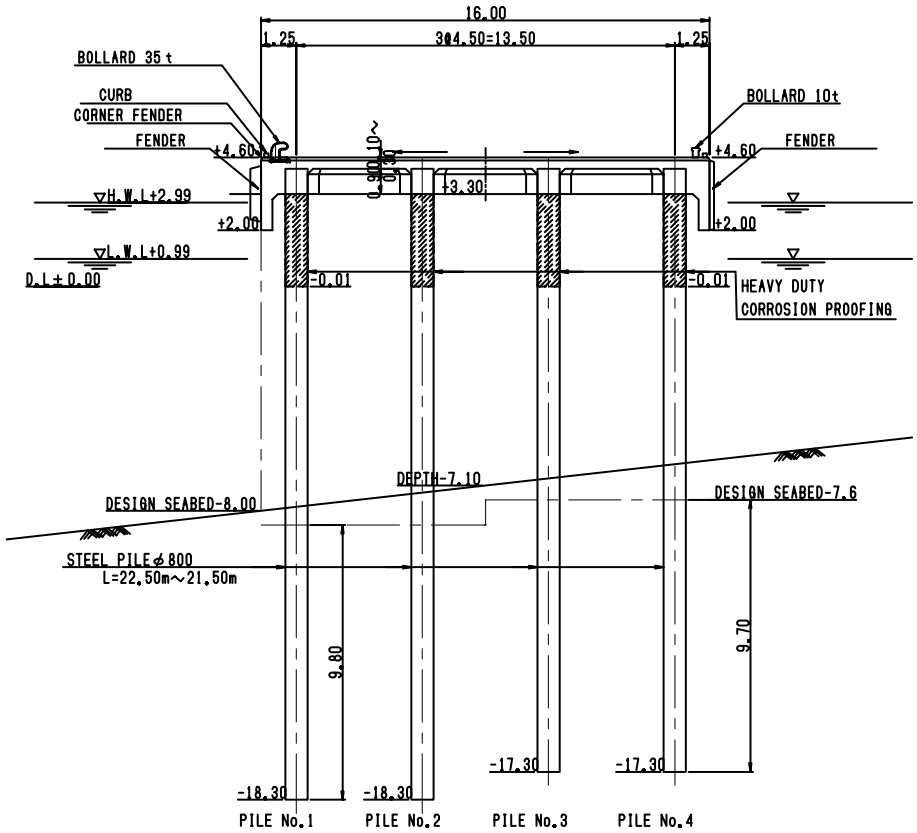
2. LAYOUT PLAN



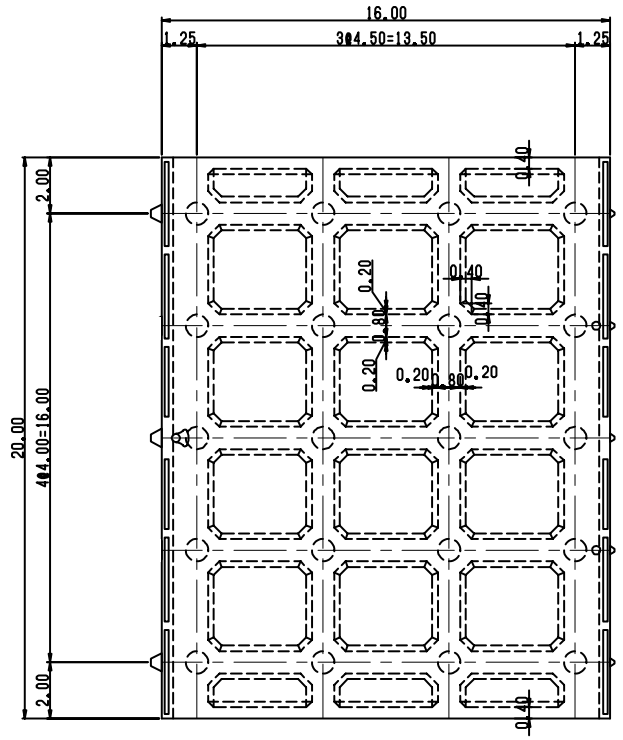
3. PLAN & SECTION OF THE WHARF

WHARF FOR FOREIGN CARGO SHIPS

SECTION



BLOCK PLAN

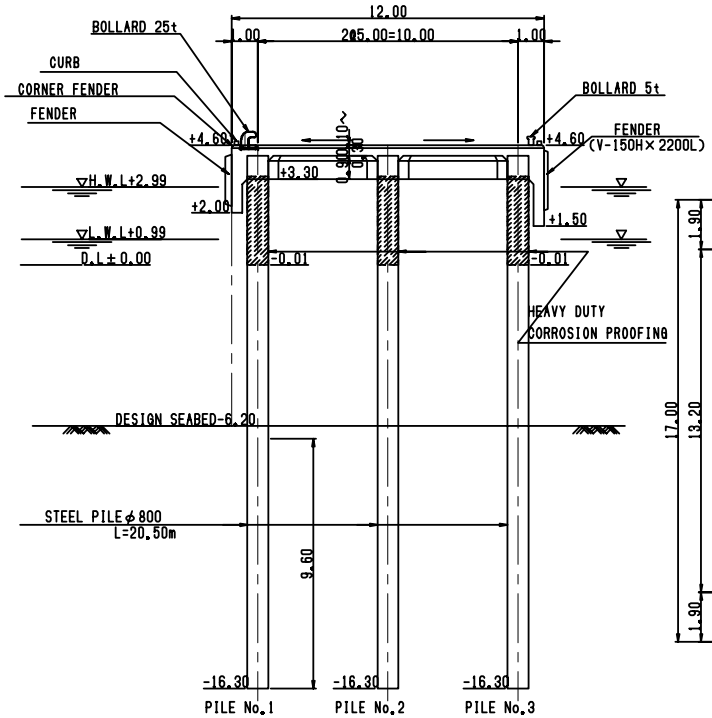


4. PLAN & SECTION OF THE WHARF FOR FOREIGN CARGO SHIPS

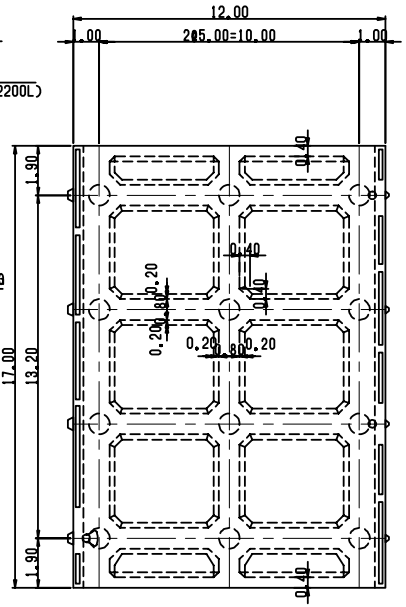
0m 5m 10m

WHARF FOR DOMESTIC SHIPS

SECTION

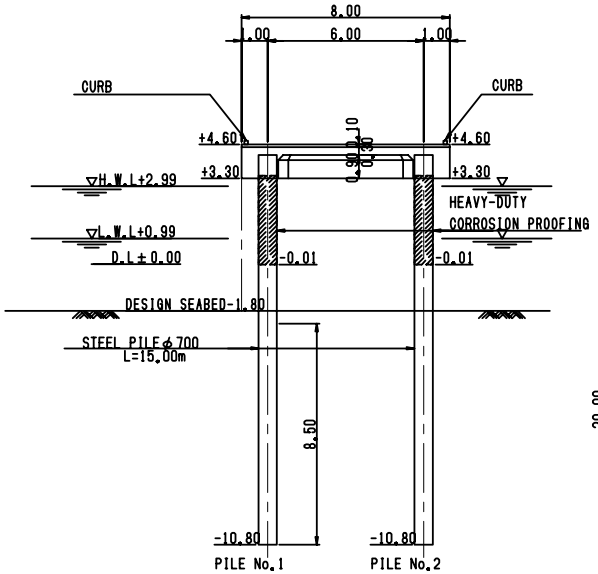


BLOCK PLAN



ACCESS BRIDGE

SECTION



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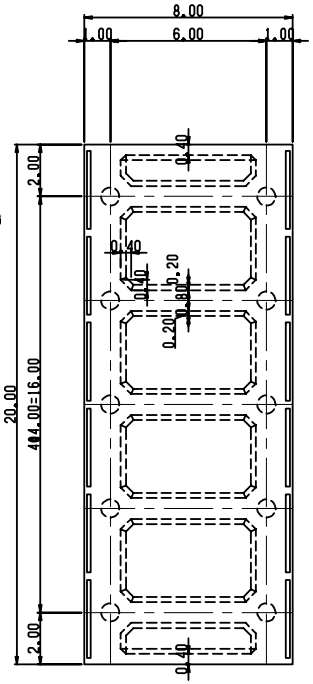
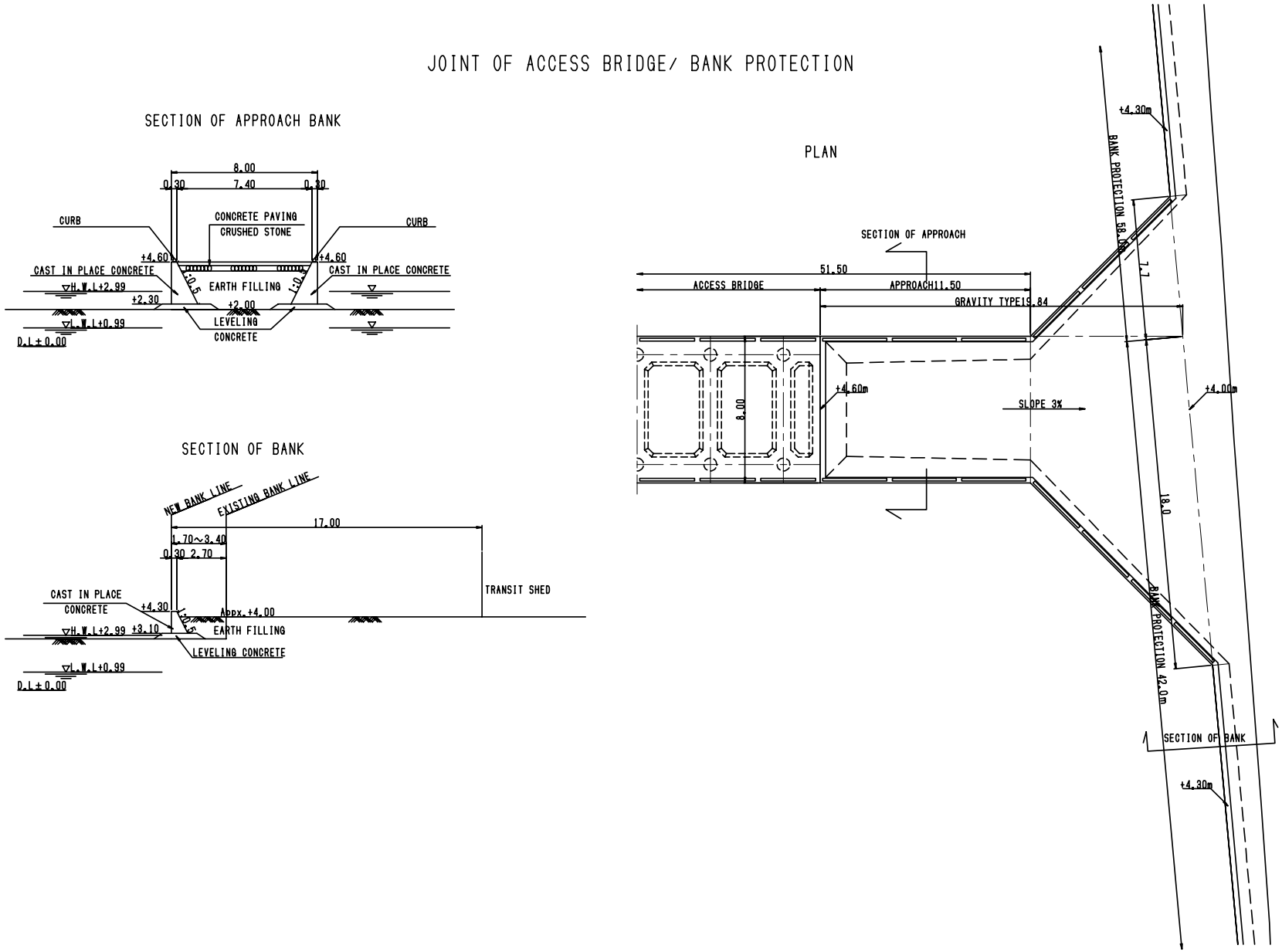


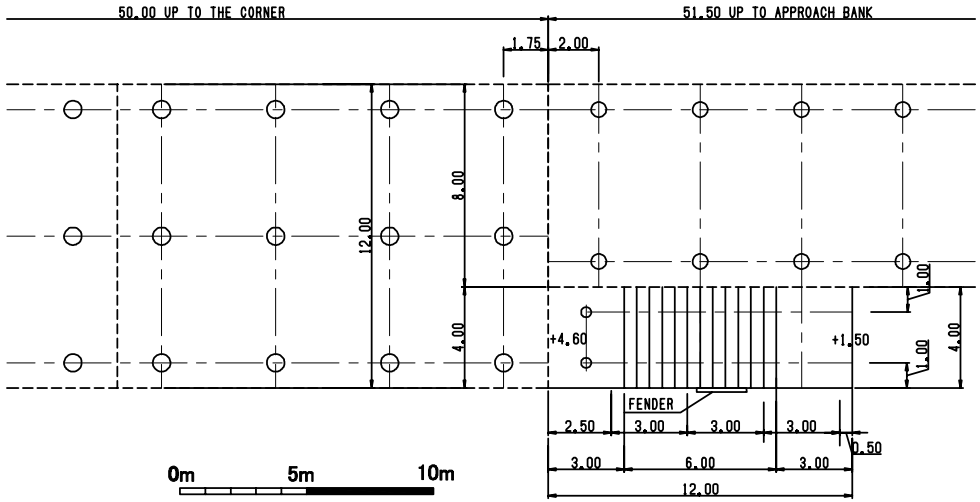
5. PLAN & SECTION OF THE WHARF FOR DOMESTIC SHIPS ./ ACCESS BRIDGE

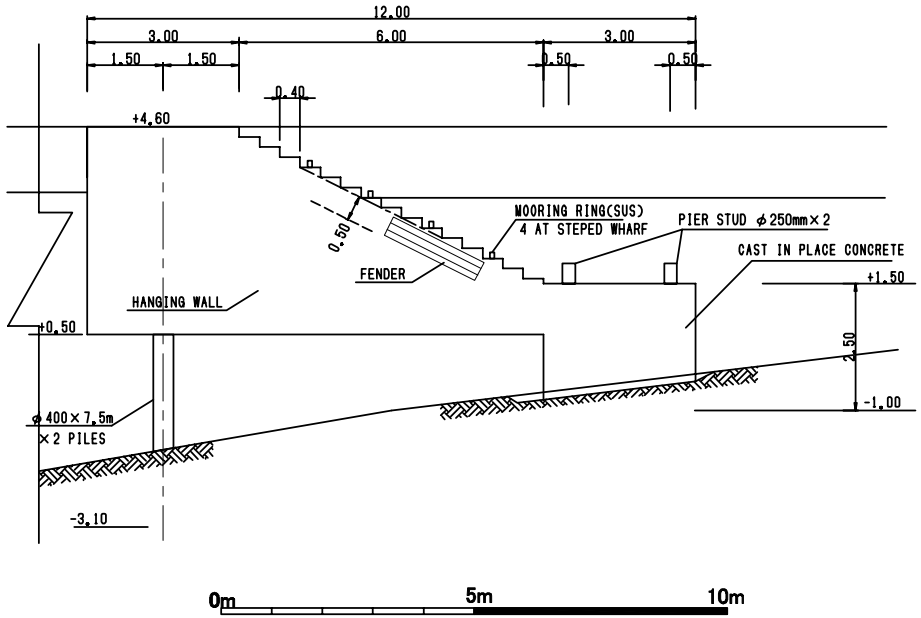
0m 5m 10m



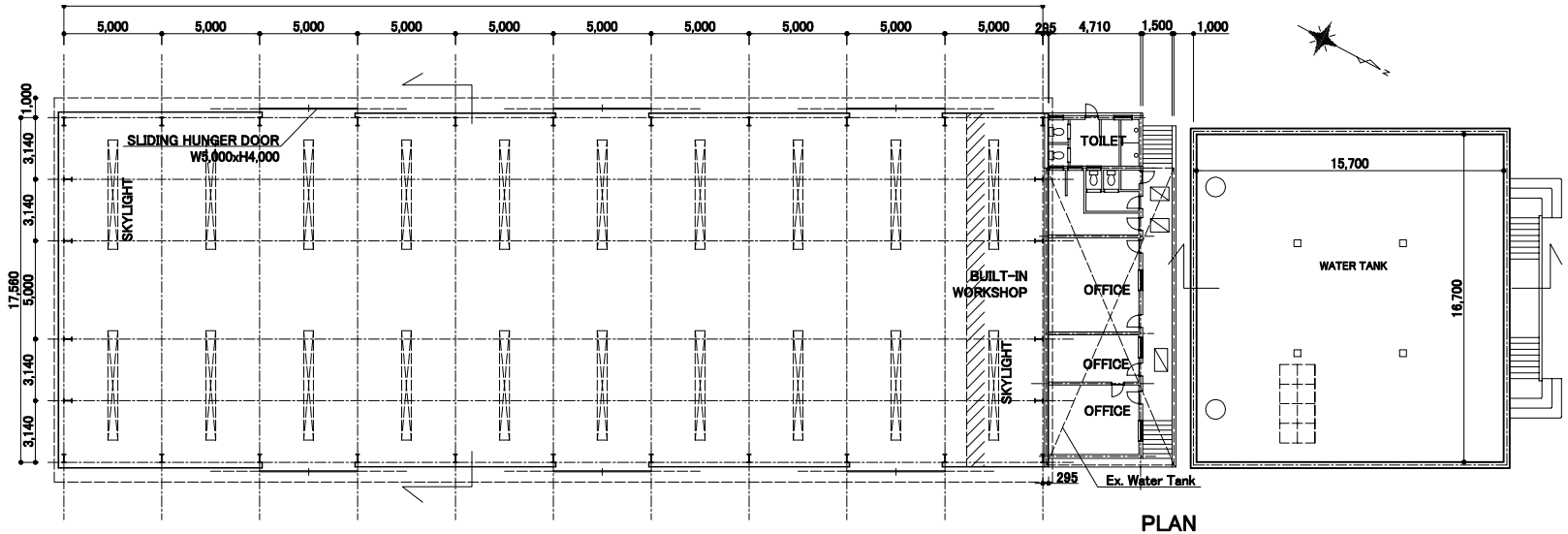
6. PLAN & SECTION OF THE APPROACH AND THE BANK PROTECTION

STEPPED WHARF FOR FISHERIES BOAT

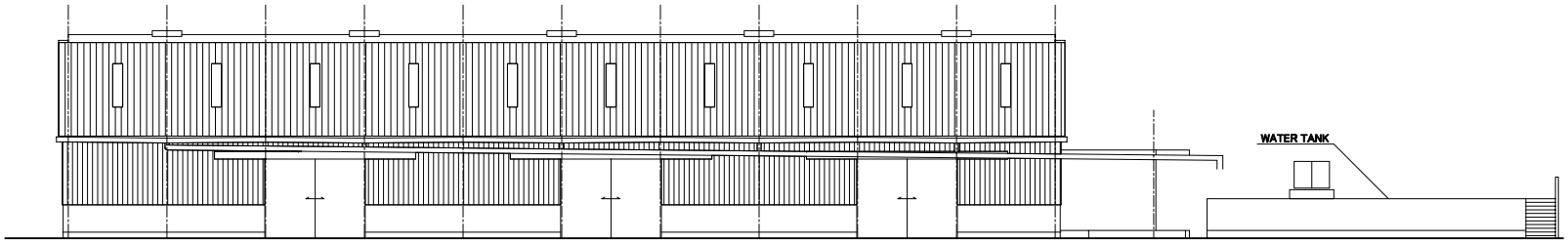




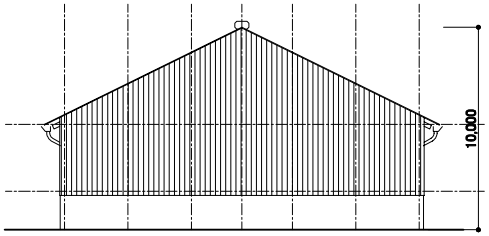
7. PLAN & SECTION OF THE STEPPED WHARF FOR FISHERIES BOAT



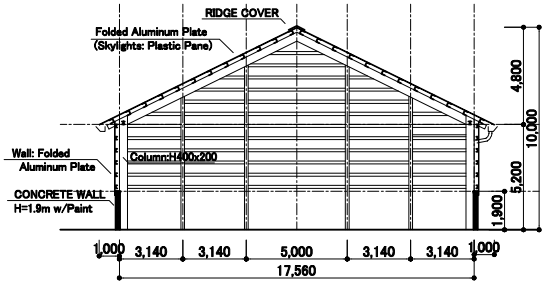
PLAN



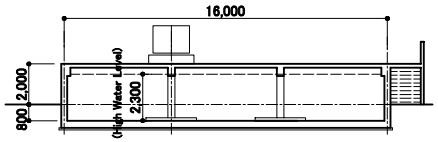
EAST ELEVATION



SOUTH ELEVATION



SECTION / WAREHOUSE



SECTION/ WATER TANK

0m 5m 10m

8. PLAN, SECTION, ELEVATION OF THE WAREHOUSE AND THE WATER TANK

2.2.4. Implementation plan

2.2.4.1. Implementation policy

(1) Construction policy

The construction plan shall be drawn up in accordance with the following policies, in light of the natural conditions and the social conditions, such as the status quo of the construction industry or other related industries in the country, based on the presumption that this project will be implemented under Japan's grant-aid scheme.

(i) When a project is to be implemented with Japan's grant-aid assistance, it is a prerequisite to strictly keep the implementation schedule. Therefore, it is vital to plan an appropriate construction schedule to accomplish all the contractual conditions within the valid period of the E/N.

(ii) The Japanese consulting company shall prepare detailed design drawings and tender documents, and take up necessary tendering procedures on behalf of the government of Tuvalu after concluding a contract for consulting services with the government.

(iii) The Japanese contractor selected as a result of the tender shall sign a construction contract with the government of Tuvalu, and carry out the construction under supervision of the consultant.

(iv) The construction plan shall conform to the climatic and meteorological conditions in the country and harmonize with the surrounding environment.

(v) The contractor shall procure the necessary equipment and materials in an efficient and adequate manner and carry out the construction of the planned facilities in accordance with the work schedule. In particular, it is necessary to conduct in-depth examination as to procurement of steel pipe piles and large construction machines.

(vi) The project site is currently used as a calling port for foreign transport ships and inter-island vessels. Since there is no alternative port, the port will continue to be used during the construction period. It is, therefore, important to have due and sufficient discussion with the parties concerned on the Tuvaluan side with regard to the demarcation of space in the premises, as it is imperative to assure the safety of passengers, vessels and cargo handling work, and at the same time secure available space for both port activities and the construction work, including a temporary yard for the construction equipment and materials, during the construction period.

(2) Procurement policy

(i) Construction materials that can be procured in Tuvalu are fairly limited. Most of the construction materials, such as cement, sand, gravel, steel pipe piles and fenders, will have to be procured in a large quantity from either Japan or a third-party country. A routine transportation means is limited to marine transportation once a month, and further, an unplanned for contingency may prolong the interval between the ships. That being the case, it is critical to start the transportation of necessary materials as early as possible, in order to avoid interruption of construction due to the lack of construction materials.

(ii) As for securement of labor, unskilled workers can be found in Tuvalu, but chief-class and skilled workers will have to be imported from Fiji. Therefore, it is assumed that the construction shall take place under such a mechanism that Fiji engineers, including chief and skilled workers, and Tuvaluan unskilled workers are blended under supervision of the Japanese major contractor. In this case, it is important to clarify the roles and responsibilities of each party concerned and give due consideration to assuring smooth operation at the site by cooperative means.

(iii) It is significant to involve Japanese engineers or engineers from a third-party country in every single process of the construction of the jetty. Thus, the project will schedule the dispatch of such engineers throughout the entire construction period.

2.2.4.2. Implementation conditions

In implementing the construction under the project, the following points must be taken into consideration.

(i) The project site is situated in an atoll. Though the meteorological and oceanographical conditions are generally calm, quite a few cyclones hit this area in the rainy season that lasts for five months from November to March. As a result, it is anticipated that there will be a lot of difficulties associated with steel pipe piling and concrete work during this period. Thus, in the project, the construction schedule shall be drawn so that the rainy season is assigned mainly to works on the ground.

(ii) It is imperative to implement countermeasures against salt damage for those structures that are located on the coastal line and hence subject to tidal winds and seawater droplets. In casting concrete for structural frames, it is significant to establish a mechanism which allows immediate and rigorous on-site inspection on the salinity content in the aggregate and concrete mixing water to be used, type of cement, mixing rate and quality of concrete, and the thickness of concrete.

(iii) Steel pipe piles are build-to-order products that need to be procured from Japan. The contractor is required to order and procure these materials as promptly as possible so as to strictly adhere to the construction schedule. For this reason, it is a priority issue, in terms of procurement, to implement meticulous management of the construction processes.

(iv) As the average maximum temperature in Funafuti is 29^{o}C - 29.5^{o}C all the year around, proper curing measures shall be put in place when carrying out concrete work, in order to prevent any cracks, etc.

(v) The construction of the jetty will be quite a dangerous marine work involving heavy construction equipment. In this water area, small-size vessels will be passing through over the construction period, and also large vessels will enter here for mooring to the bollard when calling at the port. Therefore, it is assumable that the work will have to be suspended in these cases as a countermeasure to prioritize the safety. Therefore, it is critical for both the construction workers and related personnel and the water area users to have the same recognition with respect to the range of water area involved in the construction, restriction on the use of the water area, safety procedures, and other necessary matters. Safety shall be guaranteed by keeping all parties informed.

2.2.4.3. Scope of works

Table 2-13 below shows the scope of work in the project.

Table 2-13: Scope of work of Japan and Tuvalu

	Undertakings in construction, procedures and expenses	Japan	Tuvalu
1	Appropriation of necessary land and removal of existing structures and obstacles.		○
2	Introduction of electricity and telephone line into the site.		○
3	Application and acquisition of licenses and permission necessary for the project （Environmental assessment, right to use electricity, telephones, and other infrastructure, construction license, etc.）		○
4	Consulting services including detailed design, assistance in tender procedures, construction supervision, etc.	○	
5	Application and acquisition of licenses and permission necessary for the project （authorization of building and inspection by the insurance body）		○
6	Construction and repair of the facilities （the jetty, the seawall, the warehouse, the water tank, etc.）	○	
7	Procurement of port equipment	○	
8	Import and customs clearance of equipment and materials necessary for implementation of the project		○
9	Banking Arrangement （B/A） and bank commissions for the Japanese bank		○
10	Provision for the Japanese personnel to enter and stay in Tuvalu in conjunction with the implementation of the project.		○
11	Proper and efficient operation of the facilities and equipment to be provided under the project.		○
12	Payment or exemption of any kind of value-added taxes or domestic levies imposed upon the equipment and materials and also the services to be procured by the contractor of the project in Tuvalu.		○

2.2.4.4. Consultant supervision

(1) Construction supervision plan

The project will officially commence after the conclusion of the Exchange of Notes between the governments of Japan and Tuvalu. The project will begin with the conclusion of a consulting service contract between the Ministry of Communication and Transport, the implementing agency of the project, and the Japanese consultant, with regard to detailed design and construction supervision. The works mentioned hereunder shall then be carried out accordingly. Since this project will most likely be carried out as a fisheries grant-aid assistance project, it is inevitable to cooperate with the Ministry of Natural Resources and Land.

(2) Detailed design

The consultant, based on the outcomes of the Basic Design Study, shall carry out a detailed study and draw a detailed design concerning civil engineering, building facilities and equipment of the project. The detailed design work shall cover the following items.

- Setting of the design conditions and standards
- Preparation of the design report
- Preparation of design drawings
- Calculation of quantities and cost estimation
- Formulation of the construction plan
- Preparation of tender documents

(3) Selection of contractors

After the completion of the detailed design documents for both equipment procurement and construction, the Ministry of Communication and Transport shall select Japanese contractors who will be responsible for carrying out construction and equipment procurement, with the help of the consultant. The consultant shall assist the Ministry of Communication and Transport with the following procedures.

- Tender notice
- Prequalification
- Briefing session and site explanatory meeting
- Tender evaluation
- Contract negotiations

(4) Supervision of procurement and construction

1) Supervision policy for procurement and construction

a) In order to carry out the construction and procure and deliver the equipment in a smooth fashion, the consultant shall maintain close communication and undertake detailed discussions with the counterparts on the Tuvaluan side throughout the detailed design and procurement/construction phases.

b) In order to carry out smooth procurement and construction, the consultant shall maintain close communication and undertake detailed discussions with the counterparts on the Tuvaluan side as well as the contractors, and provide adequate advice and instructions as necessary.

c) Construction will require expertise concerning the tie-in work with the existing facilities and power/water systems and installation work for the related facilities and equipment. For this reason, the project shall establish a construction supervision system consisting of Japanese experts in their respective fields with the permanent supervisor playing the central role.

d) The consultant shall provide the contractors with guidance to ensure that the port equipment will be handed in a proper fashion adequately and initial training necessary for operation and maintenance of the equipment will be conducted.

2) Details of the procurement/construction supervision

The consultant shall be responsible for the following procurement/construction supervision works.

a) Cooperation in concluding procurement and construction contracts

The consultant shall prepare tender documents, consisting of tender qualifications, proposed execution contracts, technical specifications and design documents, and cost estimates that are necessary for holding tenders. The consultant shall also participate in the tender and the signing of the contracts, explain the cost estimates, and provide evaluation and advice in selecting the contractors and deciding upon contractual conditions.

b) Guidance to the contractors

The consultant shall provide necessary and appropriate instructions concerning the implementation methods and processes after examining the procurement and construction plans.

c) Examination and approval of construction and production drawings

The consultant shall examine and approve the construction and production drawings and material and finishing samples.

d) Supervision of procurement and construction

The resident engineer and technical experts to be dispatched shall approve the equipment and materials to be procured, confirm the construction methods, implement quality control procedures, and provide guidance on installation of the procured equipment.

e) Participation in inspections

The consultant shall perform on-site inspections at interim stages during the construction and utilization of the equipment as necessary, and a final inspection at the end of construction. The consultant shall also participate in performance checks before the handover of the equipment as necessary, accept the equipment, and confirm the results of training and guidance concerning operation and maintenance.

f) Reporting on the progress of the work

The consultant shall prepare a report on the progress of construction and procurement, and any issues and countermeasures associated with the work, and report to the related organizations in the government of Tuvalu, the Japanese Embassy in Fiji, and JICA, as necessary.

g) Participation in the handover events

The consultant shall verify the handover documents at the time of handing over the equipment and the newly constructed facilities after the completion of construction.

h) Cooperation in the procedures to approve payment

The consultant shall assist in verification of the completed construction work, inspection of invoices, and payment procedures.

(5) Procurement supervision

1) Main equipment and materials

Major construction materials to be used in the project include sand, gravel, concrete blocks, cement, broken stones, backfilling earth, and so forth, all of which will basically be procured from Japan or a third-party country and delivered by ocean-going vessels. Moreover, other construction related materials, such as steel products, steel fittings, fixtures, electrical appliances, sanitary facility goods, shall be procured in the same way. As a result of studying the quality, stability and price, Japanese

products, such as steel pipe piles, steel bars, fenders, bollards, and other incidental fixtures, shall be utilized. Likewise, a part of facility equipment and materials shall be procured from Japan since it is essential to construct a reliable system. Table 2-14 below summarizes the source countries for procuring the main construction equipment and materials to be used in the project.

Table 2-14： Procurement sources for major construction equipment and materials

	Major construction materials	Japan	Tuvalu*1	3rd-party country*2	Remarks
1	Gravel			○	These are procurable as well as inexpensive in a third-party country.
2	Cement			○	
3	Aggregates for concrete			○	
4	Doors and fittings	○			
5	Wood products		○	○	
6	Roofing material	○			Assurance of quality
7	Steel bars	○			
8	Steel frame	○			
9	Wiring and lighting apparatus	○			These shall be procured from Japan with an emphasis on quality and stable supply.
10	Plumbing and sanitary equipment	○			
11	Pumps and valves	○			
12	Power distribution board	○			
13	Paint	○			
14	Steel pipe pile	○			
15	Fenders	○			
16	Bollard	○			

*1) Produced locally.
*2) Basically imports but some are easily procured in Tuvalu.

2) Main construction machinery

It is difficult to procure construction machinery to be used in the project in Tuvalu. As a result of examining the past grant-aid procurement projects and investigating the possibility of procuring from third-party countries, the source countries for the main construction machinery necessary for the project are shown in Table 2-15.

Table 2-15： List of major construction machinery

Major construction machinery	Procurement	
	Japan	Tuvalu
Barge and tug boat	○	
Piling machine or ship	○	
Crawler crane	○	
Truck crane	○	
Vibrolator	○	
Tow boat		○
Backhoe		○
10-ton roller		○
Concrete mixer	○	
Generator	○	

3) Transportation plan

There are no regular ships directly connecting Japan and Tuvalu. It takes approximately two months to transport goods from Japan to Funafuti Port via Suva Port where the cargo is transloaded, including the time taken for transportation and customs clearance within Japan. Of course, if the shipment is of a large quantity, it is possible to charter a vessel to directly transport from Japan to Funafuti Port.

2.2.4.5. Quality control plan

(1) Materials

The materials to be used for the new jetty shall be controlled in accordance with the Common Specifications for Port and Harbor Facilities Construction (Japan Port and Harbor Association). The primary materials shall be produced with approval on the specifications in advance, and inspected after the completion of the production procedures.

(2) Concrete

The quality control of concrete shall be carried out in the following way.

・Cement	Confirmation on the type, standards, and performance
・Admixture	Confirmation of the test result table
・Mixing water	Salinity content
・Aggregate	Confirmation on the particle size, specific gravity, and the water absorption volume
・Trial mix	Confirmation on the concrete slump, strength, and mixing proportion

2.2.4.6. Procurement plan for equipment and materials

The port equipment to be procured under the project shall be such that it can be operated and maintained at the technical level of Tuvalu's operators, avoiding any equipment that requires a high

standard of technical skills in handling. The major equipment to be used in the project and the procurement source countries are summarized in Table 2-16.

Table 2-16： Source countries of the equipment to be procured

	Equipment	Japan	Tuvalu	Third-party country
1	Forklift （25-ton）	○		
2	Trawler	○		
3	Tractor	○		

2.2.4.7. Implementation schedule

If this project is implemented under the grant-aid scheme of Japan, an Exchange of Notes (E/N) will first be concluded between the two countries, followed by a design and supervision contract to be signed between the government of Tuvalu and the Japanese consulting firm. Detailed design, preparation of tender documents, tendering, making contracts with the selected contractors, and construction and procurement shall subsequently be carried out.

Under the grant aid project, it is important to formulate such an implementation schedule that is consistent with the Japanese budget system. It is also required to complete the construction within the preset schedule, by formulating a meticulous implementation schedule based on the status of the procurement of materials and labor force, natural conditions, etc. The following matters were taken into consideration in drawing up the construction schedule as part of the implementation schedule.

(i) Meteorological and oceanographical conditions are unstable in the rainy season (November-March)..
(ii) Steel pipe piles for civil engineering shall be procured from Japan, and it takes five months from order to arrival in the project site.
(iii) The equipment and materials to be used in the project and also engineers and skilled workers shall be imported from either Japan or a third-party country.

(1) Detailed design

In the detailed design phase, the consultant shall draw up the detailed design of each facility and equipment based on the Basic Design Study report and prepare a set of tender documents including detailed design drawings, specifications, and tender requirements. The total period of time required is expected to be 2.5 months.

(2) Tender

The contractors (Japanese companies) of the project shall be selected by the means of competitive tendering. The tendering procedure shall be carried out in the order of tender notice, reception of expression of interest, prequalifications, distribution of tender documents, tender opening, tender evaluation and contracting with the successful tenderers, and is expected to take approximately 2.5

months.

(3) Construction

The contractor shall commence work immediately after signing the construction contract. In the meantime, procurement of built-to-order steel pipe piles will require a total of five months between order and arrival in Funafuti, including three months for fabrication and two months for ocean transport and customs clearance. The construction work shall start as soon as the steel pipe piles arrive at Funafuti Port, and will take ten months in total including construction of the jetty and the water tank, repair of the warehouse and development of the seawall. In total, 15.0 months will be required as the implementation period for the entire project.

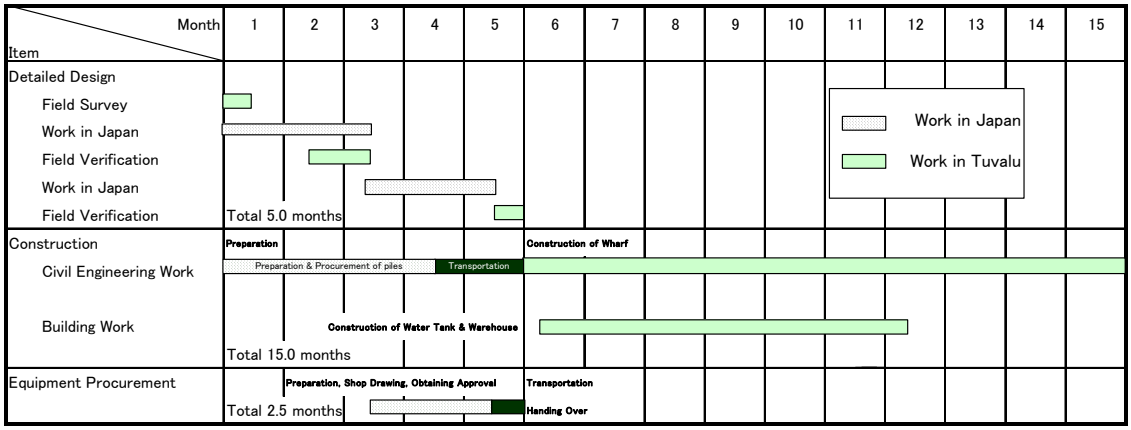


Fig. 2-17： Implementation schedule

2.3. Obligations of the Recipient Country

In implementing the project, it is vital that the Tuvaluan side will carry out the following undertakings within the agreed period of time.

(1) Appropriation of the project site, removal of existing structures, and preparation of the land

Though the whole project site is a rented land, there is no legal problem in acquiring the premises. The recipient country is expected to remove a part of the existing buildings in order to make adequate room for the new cargo handling flow and prepare the land. The cost to be incurred is estimated at approximately 10,000 Australian dollars.

(2) Securement of a temporary site

The recipient country must secure a temporary site for construction works. Further, since a part of the container yard will be unavailable during construction, it is necessary to secure an alternative yard as well.

(3) Introduction of electricity and telephone line

Electricity and telephone line must be introduced into the construction site in a timely manner at the

cost of the recipient country. Since the power to be supplied to the target facilities shall be branched from the existing main distribution board, the watt-hour meter will be set up at a specific location by the power company. If the recipient country needs an additional watt-hour meter to calculate the tariff from a management point of view, the Tuvaluan side will have to draw another power line into the premise by themselves.

(4) Redevelopment of the watchmans hut, the gate, and other exterior facilities

In association with the redevelopment of the access road, it will be necessary to redevelop the watchman's hut and the gate. The costs to be incurred are estimated at approximately 15,000 Australian dollars.

(5) Application procedures and acquisition of licenses in conjunction with construction (permission for construction, use of power, water, and other infrastructure, construction license, etc.)

(6) Exemption from any taxes or levies imposed upon any equipment or materials to be imported to Tuvalu in conjunction with the project and prompt customs clearance thereof.

(7) Exemption from value-added taxes, etc.

(8) Banking Arrangement (B/A) with a Japanese bank with respect to payments provided for in the project contract.

(9) Exemption from any taxes or duties to be imposed on the Japanese personnel in providing services associated with the project in Tuvalu.

(10) All other matters that are necessary for the implementation of the project and are not covered by the undertakings of the government of Japan.

2.4. Project Operation Plan

(1) Organization for operation

The Department of Marine shall be responsible for operation and maintenance of the facilities and the equipment to be provided under the project. However, Tuvalu Cooperative Society Ltd. (TCS) has a greater understanding regarding the receipt of goods at the port, and, at present, oversees the handling of imported goods. Thus, it is vital to work closely with the TCS and hence it is necessary to establish a strong collaborative relationship with TSC in order to achieve the efficient handling and distribution of goods in the country.

Meanwhile, the Department of Marine does not have its own internal construction division, and has previously requested the Public Works Division (PWD) to carry out any repair work to the existing jetty. Jetties are positioned so as to form an essential part of infrastructure for the distribution of goods in the country, and cannot be replaced by anything else. Thus, the PWD is expected to contribute to social and

economic activities by adequately maintaining the jetties. In order to maintain the new jetty in the short and long term, it is a must to detect any damage as early as possible and take the necessary precautionary measures. Therefore, it is vital for the Department of Marine and the PWD to strengthen their collaborative relationship concerning regular inspection and necessary repair of the facilities and carry out maintenance activities together after the implementation of the project.

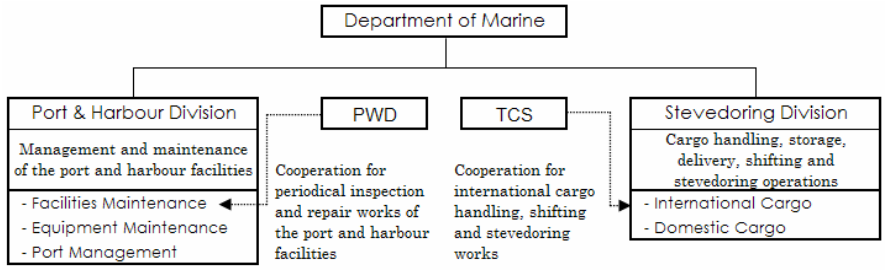


Fig. 2-18： Cooperative structure concerning operation and maintenance of the project

(2) Maintenance method

Regarding maintenance of the facilities and equipment to be provided under the project, the work plan shall be formulated in accordance with the following details, and necessary measures shall be put in place.

1) Jetty

Pile:	Check for rust, damage, deformation, etc.
Upper structure:	Check for cracks, damage, etc. and undertake cleaning
Fender:	Check for damage and adequacy of mounting bolts
Bollard:	Check for damage and adequacy of mounting bolts
Water supply:	Check for damage, deterioration, water leakage, clogging, etc. and confirm adequacy of valves, etc.
Power supply:	Check for electric leakage, broken wires, power distribution, etc.

2) Warehouse

Steel frame:	Check for rust, damage, deformation, etc.
Roof/walls:	Check for rust and damage and undertake cleaning
Eaves gutter:	Check for rust and damage and undertake cleaning

3) Water tank

Skeleton:	Check for cracks, fracture, water leakage, etc.
Inside the tank:	Periodically remove dust, sediment, etc. and undertake cleaning
Water supply:	Check for damage, deterioration, water leakage, clogging, etc. and confirm adequacy of pumps, valves, etc.
Water quality:	Periodically inspect quality, including bacteria tests

4) Other items

Outdoor light:	Check for damage and confirm its still working

5) Equipment

Implementation of maintenance and inspection activities in accordance with the respective manuals and early securement of spare parts

2.5. Project Cost Estimation

2.5.1. Initial cost estimation

The total cost required to implement this project is calculated as JPY921 million, of which Japan will provide 917 million. The breakdown of the costs to be borne by the Japanese and Tuvaluan sides according to the demarcation of the works between the two countries as described before is estimated as follows, based on the calculation parameters given in (3) later. However, the calculation results shall not determine the ceiling of the grant-aid amount to be stated in the Exchange of Notes.

(1) Cost to be borne by Japan

The cost to be borne by Japan in implementing the project is estimated at approximately 917 million Japanese yen.

Table 2-17: Project cost to be borne by the Japanese side

Cost item			Project cost (million yen)	
Facility	Construction of the jetty L-shaped jetty: 80.0m × 16.0m, 50.0m × 12.0m Access road: 51.5m × 8.0m	Steel pipe piling Concrete work for the upper structure Incidental facilities Electric and water works	676.1	699.8
Facility	Construction of the seawall 103 m		23.7	
Facility	Installation of the water tank 600 m^3		32.7	
Facility	Repair of the warehouse		79.1	
Equipment	25-ton forklift Trailer/tractor		42.8	
Detailed design/ supervision			62.7	

Total project cost approx. 917 million JPY

(2) Cost to be borne by the recipient country

The cost to be borne by the Tuvaluan side, when implementing the project under Japan's grant-aid assistance scheme, is estimated at approximately 25,000 Australian dollars, equivalent to approximately JPY2.5 million. The breakdown is provided hereunder.

1) Removal of the existing structures and preparation of land	A$ 10,000	(approx. 900 thousand yen)
2) Provision of exterior safety facilities	A$ 15,000	(approx. 1,350 thousand ye)
3) Banking arrangement	A$ 15,000	(approx. 1,350 thousand yen)
Total	A$ 40,000	(approx. 3,600 thousand yen)

(3) Calculation parameters

1) Time of calculation	November 2006
2) Exchange rate	1.00 US$ = 116.63 yen 1.00 AU$ = 90.11 yen
3) Implementation period	Implementation period for detailed design, construction and procurement are as proposed in the implementation schedule above.
4) Others	This project shall be carried out under Japan's grant-aid assistance scheme.

(4) Points to be noted in the implementation of the project

1) Securement of a temporary yard

As the port area is not spacious, it is difficult to acquire space to temporarily place steel pipe piles, reinforcing bars, cement, aggregate, and other equipment and materials necessary for the construction of the facilities. Thus, it is necessary to allocate a part of the container yard to be used as a temporary yard.

2) Prompt duty-free customs clearance

In the construction of the project, it is necessary to first carry out steel pipe piling works before any other work. It takes approximately five months to procure steel pipe piles, and hence, taking the time periods for the piling and concrete works into consideration, there is no allowance for any additional time that might be taken for customs clearance, thus, it is important to assure prompt duty-free customs clearance. A delay in the customs procedure will have a significant impact on the construction schedule.

2.5.2. Operation and maintenance cost

Operation and maintenance of the planned facilities are to be carried out on a continual basis by the Marine Department of the Ministry of Communications and Transport. In this section, an estimate has been prepared regardin maintenance and administrative costs for the planned facilities as a benchmark for the Marine Department in developing future budgets for ongoing facility operation. Since no staff increases nor changes in operating content are anticipated and the Marine Department will be able to calculate personnel and activity budgets or the assumption that present activity patterns will continue, our calculations have been limited to a consideration of power and maintenance costs associated with the renewal of the existing facilities.

(1) Power costs

Security lighting	0.4 kW x 5 units x 10 hrs x 365 days x @0.47 =	A$ 169
Water pump	2.4 kW x 12.5 hrs/month x 12 months x @0.47 =	A$ 3,431
Total		A$ 3,600

(2) Fuel (diesel) costs

Forklift	18.5 liters/hr x 10 hrs x 20 days/year x @1.85 =	A$ 6,845
Tractor	4.0 liters/hr x 10 hrs x 20 days/year x @1.85 =	A$ 1,480
Total		A$ 8,325

(3) Maintenance costs

Table 2-18 : Annual maintenance cost estimation

Target		Frequency	Maintenance and repair activities	Estimated cost	Remarks
Jetty	Piles		Repair for rust, damage, deformation, etc.	For electrical and mechanical utilities: A$ 8,250 For warehouse and water tank: A$ 11,330	Any immediate repair of the jetty is not needed . For electrical and mechanical utilities maintenance, 5% of the building equipment installation cost is applied. As for minor repair work on the warehouse and water tank, approx. 5% of the direct construction cost is allocated.
	Superstructure		Repair for cracks, damage, etc. and cleaning		
	Fenders		Repair for damage and mounting bolts		
	Bollards		Repair for damage and mounting bolts		
	Water piping		Repair for damage, leak, clogging, valve, etc.		
	Power system		Repair for leak, broken wire, etc.		
Warehouse	Steel frames		Repair for rust, damage, deformation, etc.		
	Roofing/walls		Repair for rust, damage, etc. and cleaning		
	Eaves gutters		Repair for rust, damage, etc. and cleaning		
Water Tank	Structure		Repair for crack, fracture, leak, etc.		
	Tank inside	Yearly	Removal of dusts, sediments, etc. and cleaning		
	Water system		Repair for damage, leak, clogging, pump, etc.		
	Water quality	Monthly	Water quality inspection including bacteria test	A4 2,400	
Outdoor lightings			Repair for damage and bulbs		
Equipment		Every operation	Maintenance in accordance with the respective manuals and early securement of spare parts	A$ 20,000	Set at about 5% of equipment value.
Total annual maintenance cost				A$ 41,980	

The operation and maintenance costs increase for the facilities and equipment to be provided under the project can roughly be estimated as shown in Table 2-19 below.

Table 2-19 : Estimation of annual operation and maintenance cost increased owing to implementation of the project

Cost category	Amount
Power cost	3,600
Fuel cost	8,325
Maintenance cost	41,980
Total	53,905

The budget of the Department of Marine for 2006 is 2,510,053 Australian dollars, out of which the Department needs to allot 2.1%, or 53,905 Australian dollars, to maintenance expenses for the facilities and equipment to be provided under the project.

Chapter 3. Project Evaluation and Recommendations

3.1. Project Effect

The project is expected to bring about the following effects shown in Table 3-1.

Table 3-1: Effects of the project

Current status and issues	Measures to be taken in the project	Direct effects and the degree of improvement	Indirect effects and the degree of improvement
The deepwater wharf has a high probability of collapsing due to aging of its reinforced concrete, requiring the maximum weight of cargo in a container to be restricted and causing hindrance to efficient marine transportation. Furthermore, as it is the only jetty in Tuvalu where large-scale vessels can moor, it is anticipated that, if it collapses, the livelihood of the Tuvaluans will also likely collapse.	・Construction of a new jetty	iii) The restriction on the weight of 20-foot containers will be alleviated from the current across-the-board threshold of 18 tons to by-container norms with a total combined maximum weight of between 20 and 30 tons. iv) If the safety of the jetty is established, it can be used on a long- term basis.	iii) The project is expected to contribute to the stabilization of the rural economy of Tuvalu through promotion of fisheries in outer islands where income generation opportunity is low. iv) The cargo volume per container will increase, thereby contributing to reduction of transport costs.
Cargo handling works inevitably need to be conducted on public roads, requiring extra man hours. Further, containers are temporarily placed also on public roads due to the lack of space available for container storage on the premises, which impedes the safe passage of citizens.	・Construction of a new jetty to the south of the existing wharf. ・Development of internal aisles ・Development of the container yard	iii) The time required to transport 20-foot containers from the jetty to the yard will be shortened from 2.5 minutes to 1.5 minutes approximately. iv) The number of loaded containers that can be stored in the yard will increase from 40 to 60 approximately.	iii) The improved efficiency of cargo-handling work will reduce the time required for containerships to stay at the jetty, which should, therefore, thereby contribute to the reduction of transport costs. iv) Eliminating transportation and storage of containers on public roads will ensure the safe passage of citizens.
The short mooring berth length causes the mooring line for Nivaga II's mooring to be an obstacle to the access of other vessels.	・Development of a jetty with 80m-long berths	i) The impediments brought by the mooring of Nivaga II (9.1 days/month) will be solved.	i) Access of vessels to the port will be easier, providing greater convenience as a harbor.
In addition to the lack of cargo-handling equipment, the aging of the current equipment frequently causes failures, hampering cargo-handling activities.	・Provision of a forklift (25-ton), trailer and tractor	i) Interruption of cargo handling works due to failure of cargo-handling equipment will significantly be improved.	i) The improved efficiency of cargo handling of containers is expected to reduce the time 1 containerships need to stay at the jetty.
Due to the limited water storage capacity, if the amount of rainfall is small, freshwater to be supplied to inter-island vessels is not sufficient, thus requiring the vessels to postpone their departure and causing other hindrances to the safe operation of the vessels.	・Repair of the Warehouse ・Construction of the Water Tank	i) The water storage capacity will be expanded from 150m^3 to 750m^3.	i) The improved capacity to supply freshwater to inter-island vessels will contribute to the stabilization of ship operations.

3.2. Recommendations

(1) Securement of spare parts and budget for cargo-handling equipment

The breaking down of cargo-handling equipment seriously impacts the cargo-handling work at the port. Securement of the spare parts of the equipment involved is therefore indispensable for maintaining an efficient cargo-handling ability, but, unfortunately it takes a significant time to procure spare parts, including time required for transport. Therefore, it is essential to secure a minimum quantity of spare parts at the beginning of operations as well as preparing for smooth future procurement, such as listing up of inventory, procurement sources, prices, etc. Also, it is imperative to earmark a certain budget for the purchase of spare parts.

(2) Improvement of maintenance skills

The maintenance work for the equipment shall be carried out by personnel of the Department of Marine as has always been so. The equipment to be provided by the project requires a similar technical level to the existing equipment, and so the Department of Marine is of course capable of maintaining the new equipment. In the meantime, however, it is necessary to share repair techniques among all the maintenance personnel and also to strive for realizing periodical maintenance to prevent failure and improving maintenance skills.

(3) Improvement of cargo-handling equipment

In order to lower marine transportation costs, it is important to shorten the time required for containerships to stay at the jetty. Since the nighttime operation of large-sized vessels is prohibited at the Funafuti lagoon for safety reasons, if a ship enters the port early in the morning, it must finish the cargo handling work and depart there before dark at the latest. In order to realize this, it is necessary to shorten the time required to transport containers from the jetty to the container yard, which currently occupies the largest portion of the cargo-handling time. Since this project only provides one pair of container transporting vehicles, the Tuvaluan side is expected to purchase another set so as to achieve a higher level of cargo-handling efficiency.

(4) Establishment of a cooperative mechanism for efficient cargo handling

The cargo-handling workers at the port officially belong to the Department of Marine, but in their actual work of handling imported goods, they follow instructions from the TCS, which is the largest consignee and has the greatest experience in import activities in Tuvalu. Because the workers are paid by the Department according to working hours and TCS is responsible for these costs, the Department and TCS, which wants to reduce costs by minimizing working hours, are not necessarily on the same track in terms of interests. In order to ensure efficient cargo-handling works after completion of the project, collaboration with TCS, which is a cargo-handling expert, will be as vital then as it is at present, and therefore, it is deemed necessary to revise the operational procedure, including a review of the billing system.

(5) Maintenance and inspection of the facility

Since the Department of Marine does not have a construction unit internally, they request the PWD to repair the existing jetty when needed. In view of the fact that the jetty is the country's irreplaceable, key logistics facility, adequate maintenance is called for so as to contribute to the social and economic well-being of the country. In order to soundly maintain the functions of the jetty in the future, it is vital to detect damage as early as possible and implement accurate and proper corrective actions accordingly. To this end, the cooperative relationship between the Department of Marine and the PWD concerning regular inspection and repair must be strengthened for continuing maintenance activities after implementation of the project.