BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF THE FISH MARKETING SYSTEM IN THE OUTER ISLANDS IN THE REPUBLIC OF THE MARSHALL ISLANDS

August 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

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In response to a request from the Government of the Republic of the Marshall Islands, the Government of Japan decided to conduct a basic design study on the Project for Improvement of the Fish Marketing System in the Outer Islands in the Republic of the Marshall Islands and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Marshall Islands a study team headed by Mr. Masao Kishino, Research Officer, Research Division, Research Department of the Ministry of Agriculture, Forestry and Fisheries from April 8 to May 28, 1991.

The team held discussions with the officials concerned of the Government of the Marshall Islands, 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 the Marshall Islands in order to discuss a draft report and the present report was prepared.

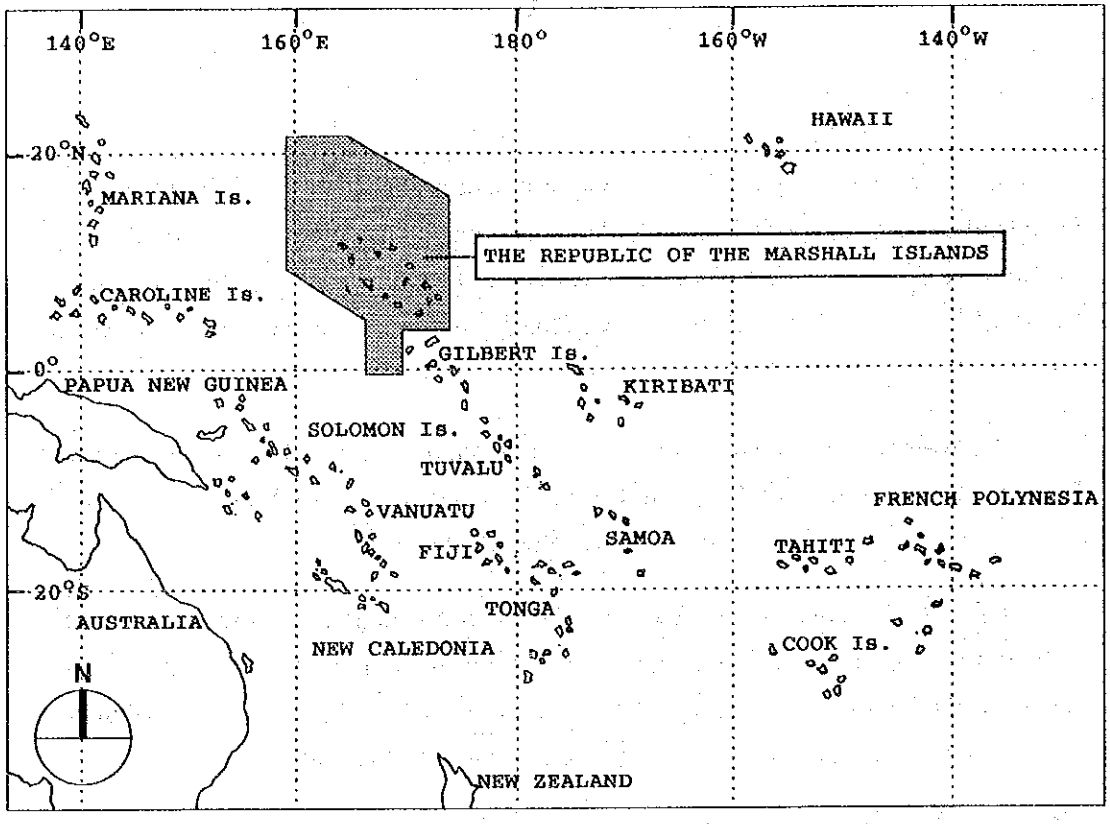
I hope that this report will contribute to the promotion of the project and to the enhancement of the friendly relations between our two countries.

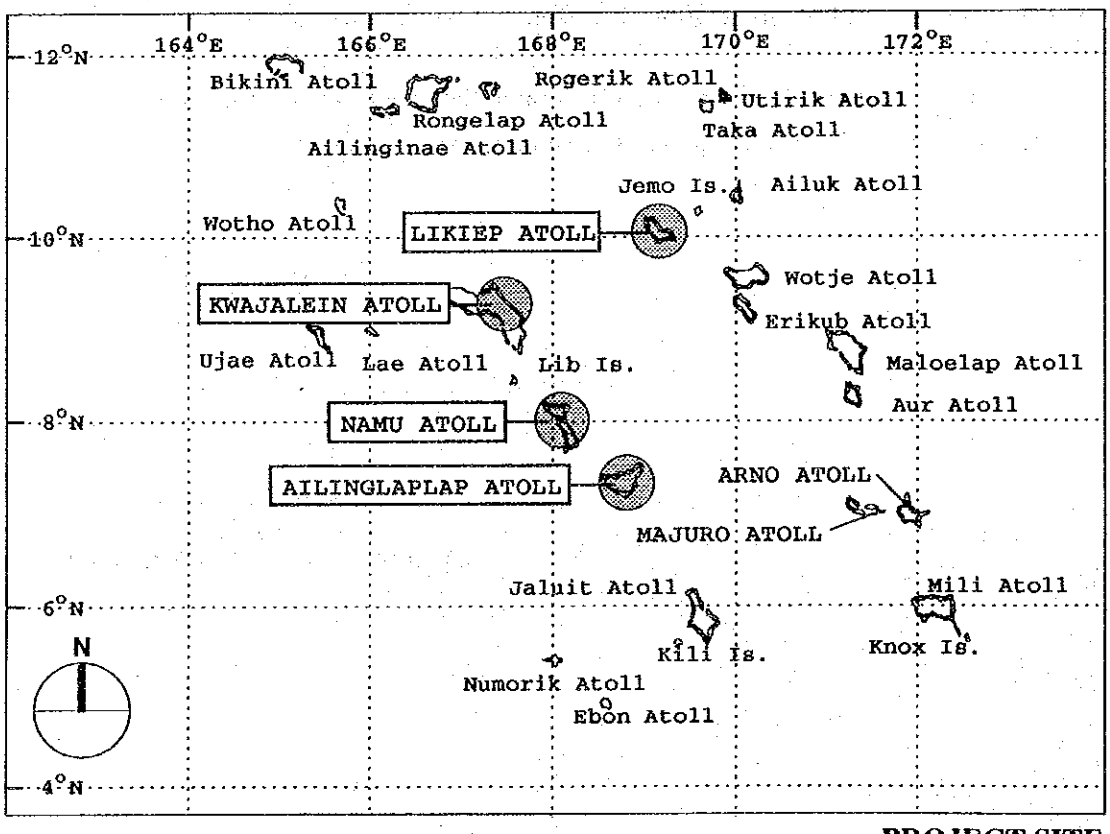
I wish to express my sincere appreciation to the officials concerned of the Government of the Marshall Islands for their close cooperation extended to the teams.

August, 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency





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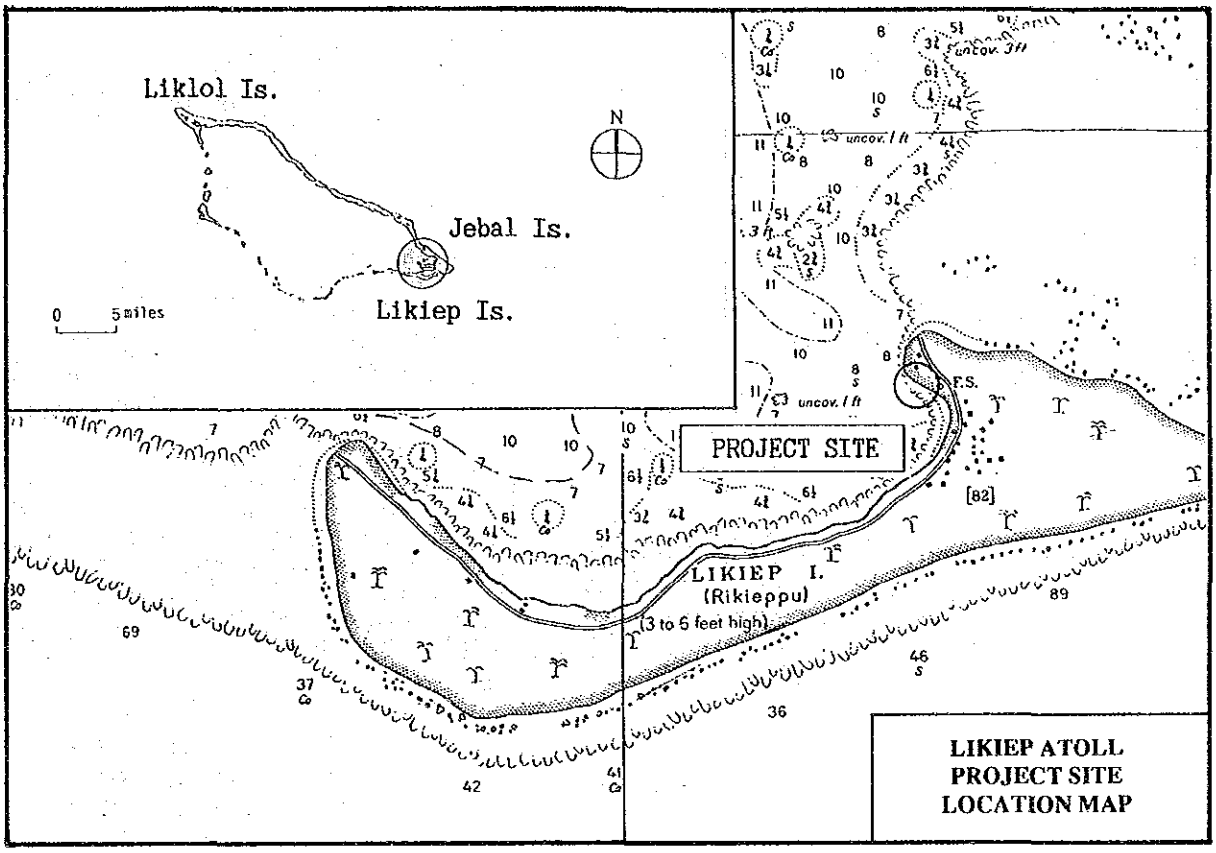
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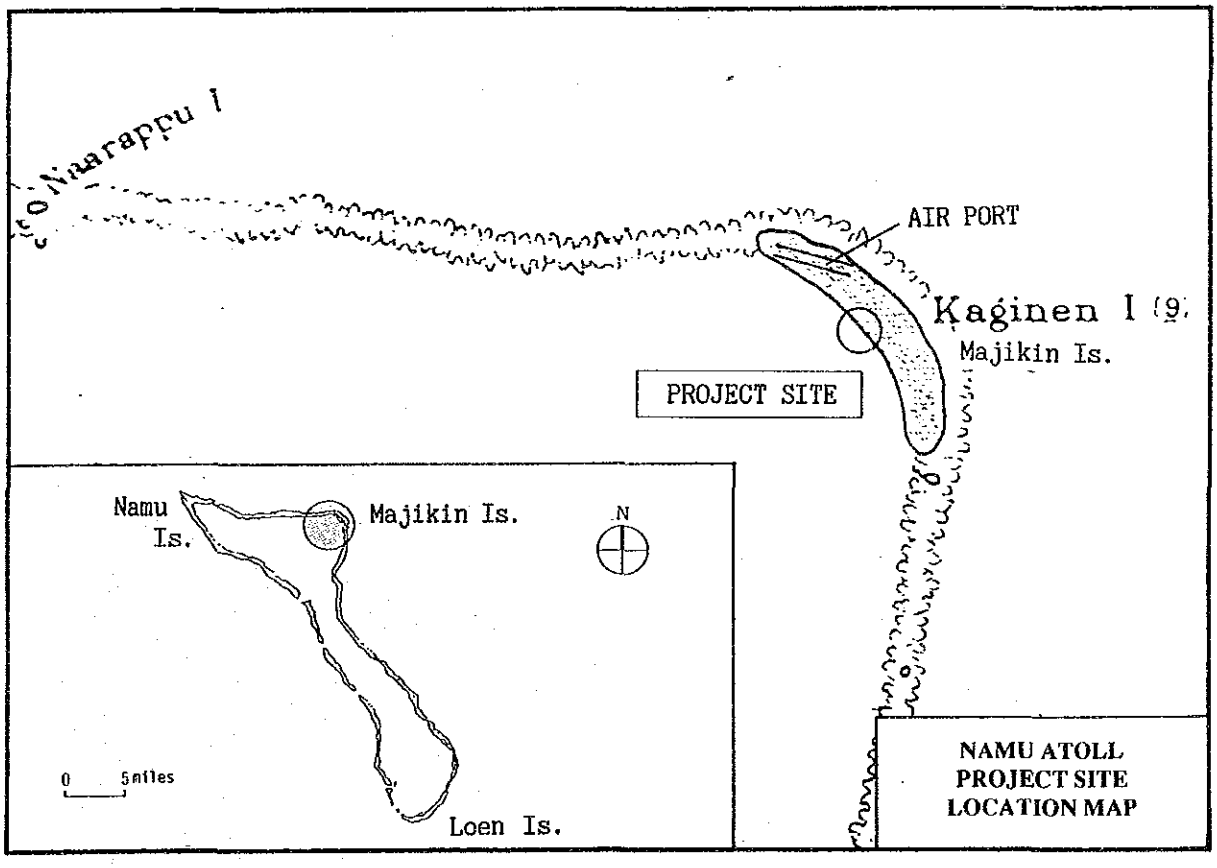
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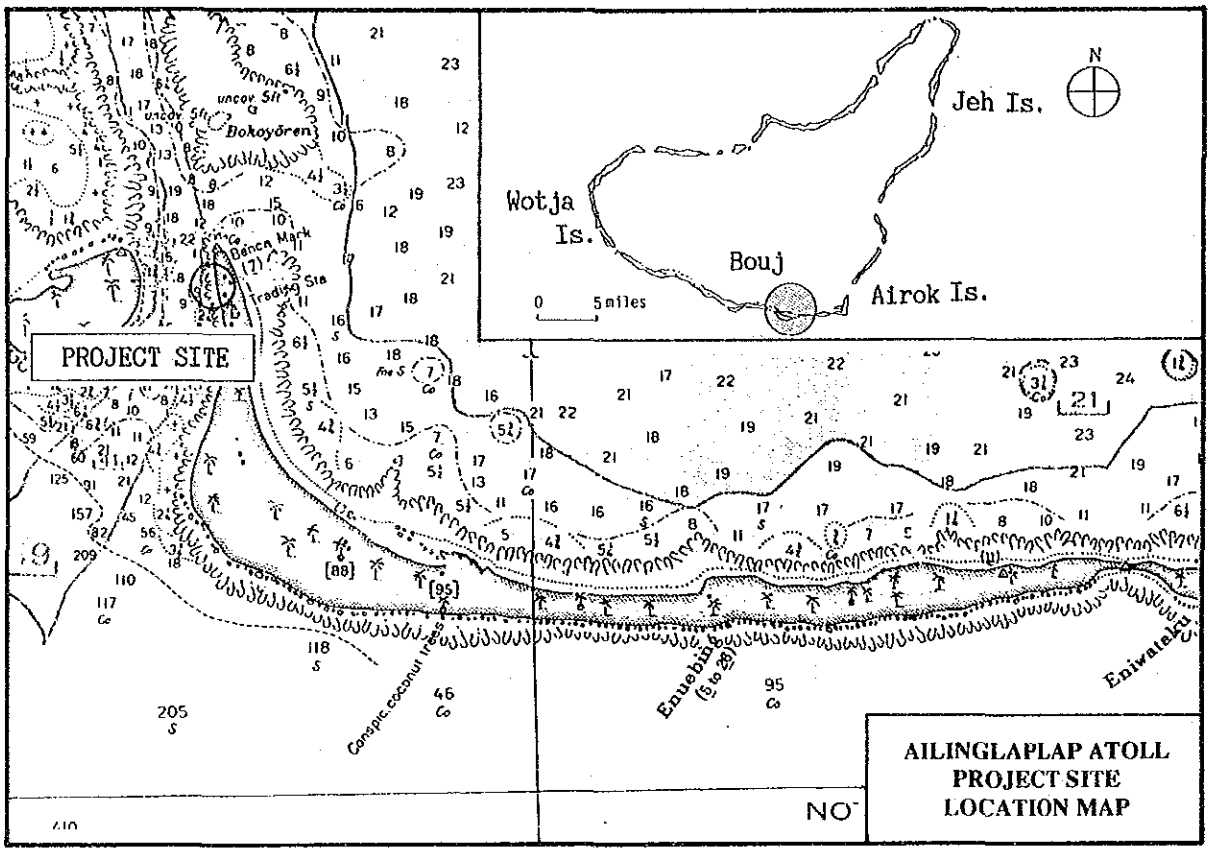
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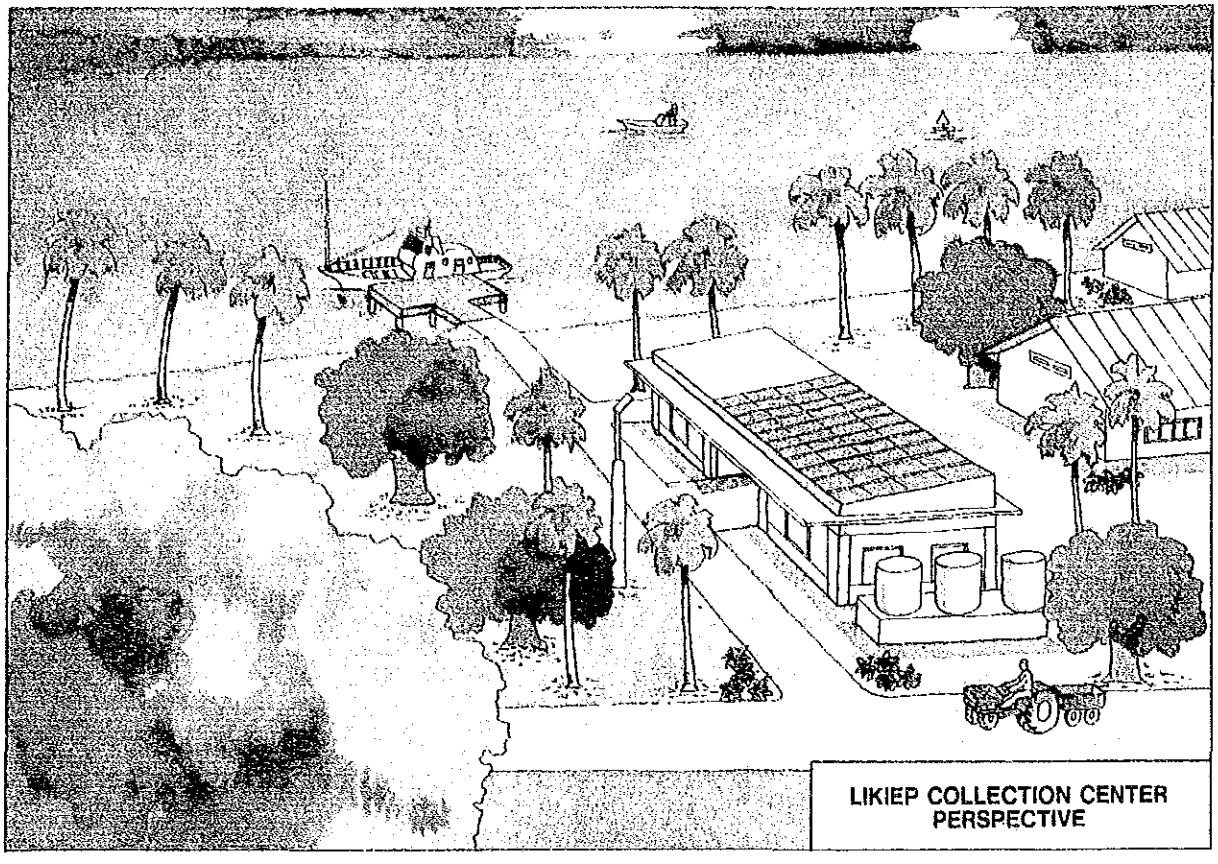

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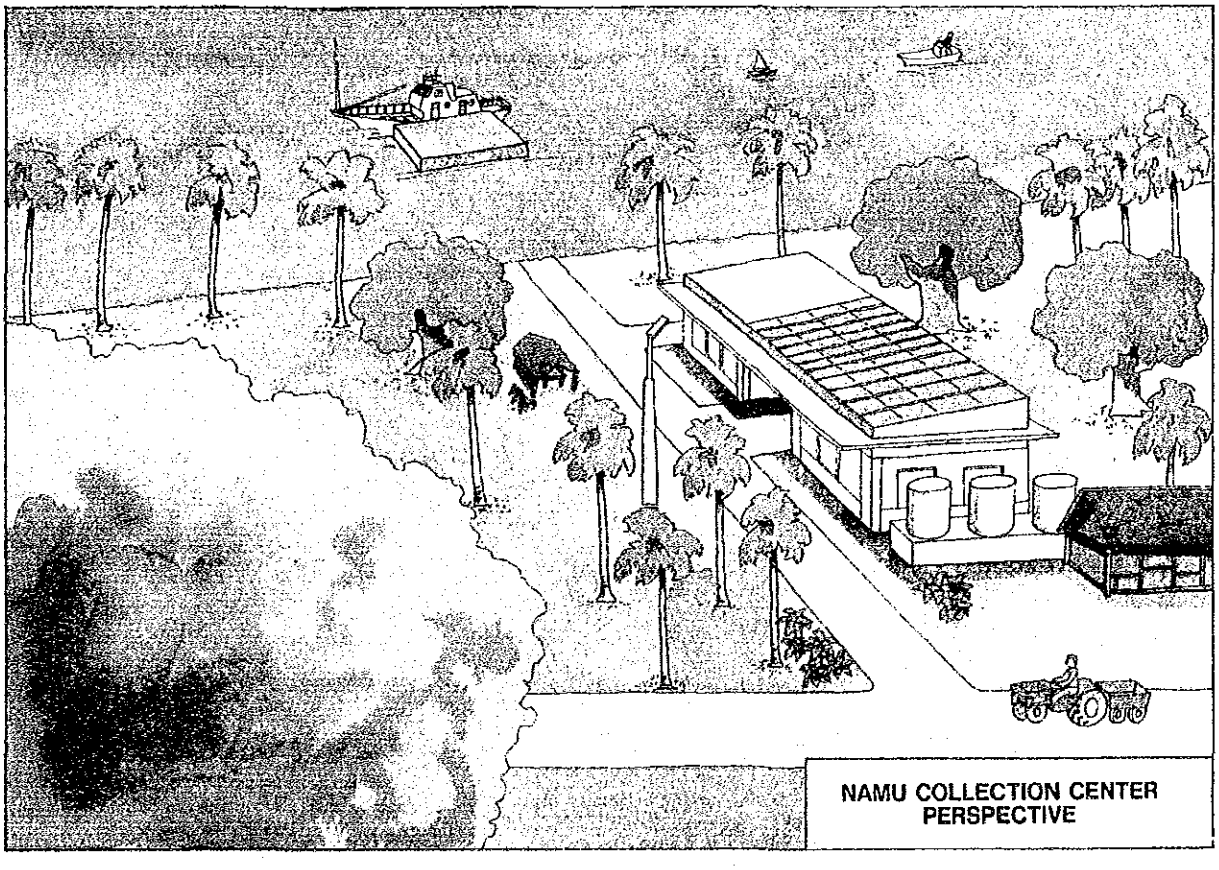
PERSPECTIVE



NAMU COLLECTION CENTER
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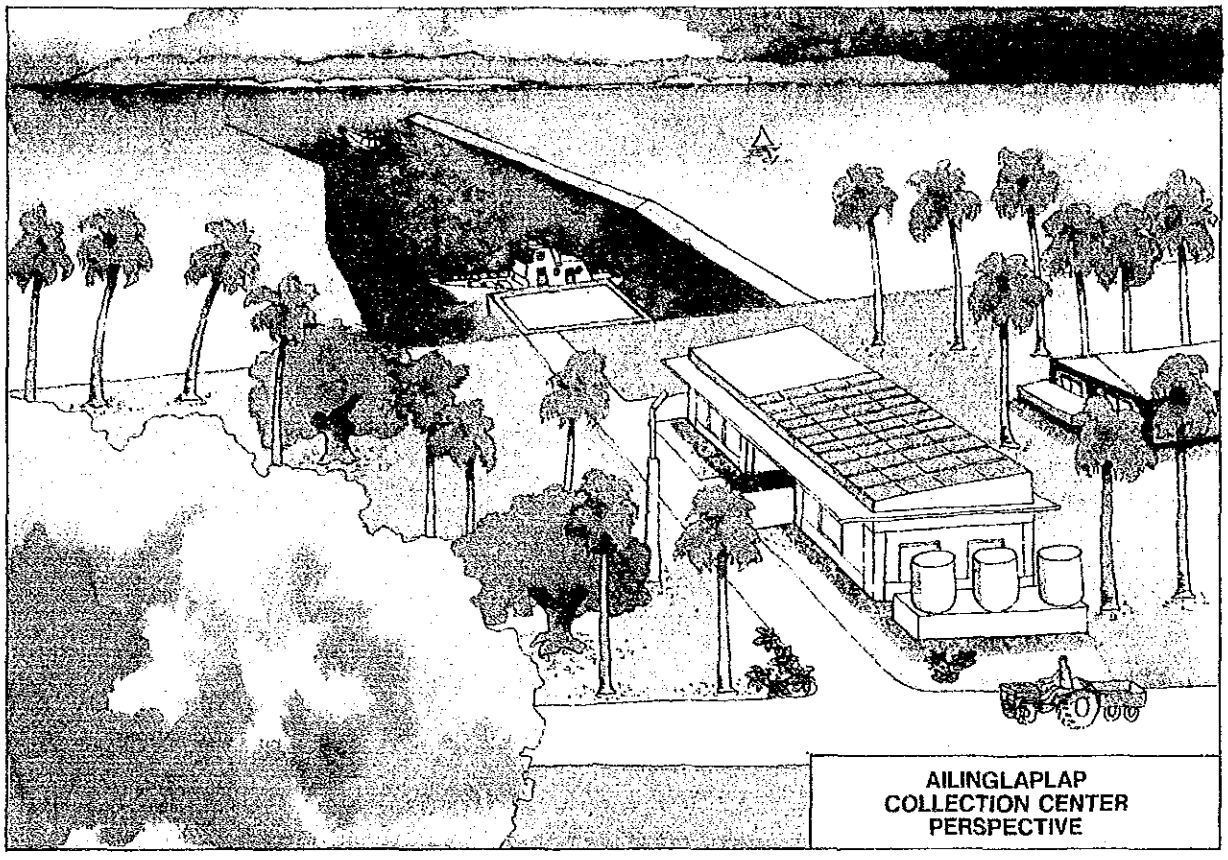

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PERSPECTIVE

SUMMARY

SUMMARY

The Marshall Islands consists of two parallel chains of 29 atolls and 5 islands in the Central Pacific between 4 and 14 degrees North latitude and 160 and 173 degrees East longitude. The total land area of the atolls and islands is 181 km^2 and its territorial waters are more than 1.94 million km^2. The climate is oceanic tropical with an average temperature of 27 °C and a daily range of less than 7 °C. The humidity is also high.

The total population at the time of 1988 census was 43,380 and there has been an increase of 12,507 persons or 40.5 percent, since the last census in 1980. Two thirds of the population are concentrated in Majuro Atoll (19,664 persons, 45.3%) and Kwajalein Atoll (9,311 persons, 21.5%). The population in Majuro Atoll and Kwajalein Atoll has increased by 67.0 percent and 39.7 percent, respectively, since 1980. The opportunities of cash income and development of infrastructure in urban areas are the main cause for the concentration of population.

Since copra production is the only main industry of the country, its economic base has always been fragile. Hence its economy is greatly dependent on financial assistance by the U.S. Government under the Compact of Free Association (1986-2001).

The basic strategy of the Draft of Second Five-Year Development Plan (1991/92-1995/96) is to develop the country's social infrastructure and thereby utilize domestic resources such as fisheries, minerals of the sea, etc., to meet consumption and investment needs, and the Plan places great emphasis on the importance of building up the nation's social infrastructure in order to achieve self-reliance. Particularly the suppression of population concentration in the urban areas, through the development of social infrastructure and thereby generating industry in the outer islands, is one of the basic policies of the nation's development.

The development objectives of the fisheries sector during the plan period are:

- to increase domestic fish production in order to replace imports and increase exports of fishery products;
- to develop the fisheries sector as a major component of the country's economic base, by encouraging the development of artisanal fishing as well as locally based commercial fishing;
- to promote locally based fish processing industries both on a small and large scale;
- to develop Majuro's international dock area for use by foreign fishing fleets as a base;

- to enhance the country's surveillance capacity within its Exclusive Economic Zone.

Based on the aforementioned objectives, the development projects are categorized into priority A and B. "The outer island fisheries development project " was planned as priority A.

Although the country has rich fisheries resources within its economic zone, only subsistence fishing is undertaken in almost all the outer islands. A major part of the fisheries production in this economic zone is due to the operation of foreign fishing vessels. The supply of fresh fish is insufficient in Majuro and Ebeye island on Kwajalein Atoll where the population is concentrated, and fresh fish consumption is supplemented by imported canned fish. In contrast there is a potential for fish production in excess of local needs in the outer islands. However, with no development of basic fishing and marketing facilities, this potential has not been fully developed.

In order to narrow the economic gap between outer islands and urban area as described above, the pilot project in Arno Atoll which is supplying fish to Majuro was implemented in 1988 with the cooperation of Japanese Government. However, the shortage of fresh fish in Ebeye, where the population is the second largest in Marshall Islands, has not yet been improved.

Under these circumstances, the Government of Marshall Islands requested grant aid from the Government of Japan for the provision of facilities and equipment for fisheries development in the outer islands, for the purpose of upgrading the income of outer islands' people and narrowing regional economic gap through establishment of stable system to supply fish to Ebeye and promote small-scale fisheries.

On receiving this request, the Japanese government evaluated its appropriateness and significance and a basic design survey team was dispatched by the Japan International Cooperation Agency (JICA) to the Marshall Islands from April 8, 1991 to May 28, 1991. The survey team confirmed the background and objective of the request, and conducted a survey on the social and economic conditions in the proposed Project area, the activities of the existing fishery, the distribution system of fish, basic infrastructure, the suitability of construction sites, etc.in the proposed project area. The significance and appropriateness of the Project was deliberated and the basic design of the Project was formulated.

A draft final report mission was sent by JICA to the Marshall Islands for final discussion and confirmation of the contents of the basic design report of the Project from August 4 to 13, 1991.

Based on the result of field survey, it was concluded that the plan to supply and transport fish from the three atolls to Ebeye is appropriate from the view point of the national development policy, fish resources management and effects of the Project. Each facility and equipment was examined and planned based on the result of the field survey after thoroughly considering local conditions for management and maintenance, technical level, natural conditions, construction conditions, etc. Consequently, landing facilities for the transport boat were not included for Namu atoll since it was observed that the shoreline on the lagoon side is being eroded conspicuously. Outline of the facilities and equipment is as follows.

(1) Landing Facilities and On-Land Facilities

Facilities	Likiep	Namu	Ailinglaplap
1) Landing Facilities	Piled jetty (Berth 10 m, water depth -2.0 m	No jetty Small barge (6 m x 3 m)	Gravity type wharf (Berth 10 m, water depth -2.0 m, access channel, approxi.1,800 m^2)
2) On-land Facilities	Fish storage 18 m^2 Battery room 12 m^2 Work space 30 m^2 Office 19 m^2 Storage 4 m^2 Fuel depot 7 m^2 Water tank (3 tons) 3 Toilet 1 set	- ditto -	- ditto -
3) Utilities for On-Land Facilities	Solar power system Solar panels 120 sheets Inverter 2 sets Control panel 2 sets Battery 1 set Emergency generator 1 set Chest freezer (450 *l*) 3 sets Water supply & drainage 1 set Septic tank & filtration sump 1 set SSB radio-telephone 1 set Fluorescent light 40W) 6 sets Street light (20W) 1 set	- ditto -	- ditto -

(2) Equipment List

Equipment	Likiep	Namu	Ailinglaplap
(1) Transport Boat (Length: 15 m)	---------- 1 ----------		
(2) Fishing Boat Length: 9 m)	1	1	1
(3) Fishing Gear			
1) Spear Set	20 sets	20 sets	20 sets
2) Drive-in net	2 sets	2 sets	2 sets
3) Gill Net	4 sets	4 sets	4 sets
4) Hook and Line	4 sets	4 sets	4 sets
5) Lantern for flying fish	6	6	6
6) Floating Cage	2 sets	2 sets	2 sets
7) Insulated Box	20 sets	20 sets	20 sets
8) Scale	2 sets	2 sets	2 sets
9) Rain Wear	10 sets	10 sets	10 sets
10) Drums (4 drum for Transport boat; in total 16)	4	4	4
(4) Equipment for Fishing Village			
1) Bicycle Trailer	2 sets	2 sets	2 sets
2) Compact Tractors	1 set	1 set	1 set
3) Repair Tools	1 set	1 set	1 set

On the facilities which are to be provided by this Project was designed as to minimize the adverse environmental impacts, and it is concluded that construction of facilities will not bring any serious problems on erosion of shoreline, marine biological environment, etc.

The portion of construction costs to be borne by the Government of the Marshall Islands is estimated at US$ 4,872 excluding land cost.

The construction period will be divided into two phases; the planned period for phase 1 is 11 months and for phase 2 is 9.0 months.

Phase	Contents
Phase 1	Construction of off-shore and on-land facilities in Ailinglaplap and provision of equipment.
Phase 2	Construction of off-shore and on-land facilities in Likiep and Namu and provision of equipment.

The executing agency, Marshall Islands Marine Resources Authority (MIMRA) will be responsible for the operation and maintenance of all facilities provided in the Project.

A semi-public organization consisting of MIMRA staff and members from the private sector is planned for the operation and maintenance of each fish collection center in the outer islands and for the sales of its fish catch. The implementing and operating costs for the Project are to be allocated from special government budget based on the request of MIMRA.

Implementation of the Project is expected to narrow the economic gap between the outer islands and the urban areas by developing the existing fishery from the traditional self-sufficient type, to a source of cash income and by supplying fish periodically from the outer islands to Ebeye Island where the population is concentrated. This is in accordance with the foremost goal of the national development policy of the Government of the Marshall Islands to develop local industries in the outer islands in order to close the economic gap between urban and rural areas.

The annual volume of fish products collected from the islands is anticipated to be approximately 50.4 tons and with the increase in added value, it is estimated that annual benefit will be about US$50,400. In addition, this is expected to contribute to an increase in annual consumption of fresh fish by 5.2 kg per capita in Ebeye Island with a population of approximately 9,600 people. It is anticipated that the Project will help decrease imported canned fish consumption. A decrease in the consumption of imported canned fish, will lead to saving in foreign currency. It is estimated that approximately 50.4 tons of fresh fish annually will replace the annual volume of about 26.7 tons of imported canned fish or US$49,900.

Currently the distribution of commodities mainly copra between the outer islands and the heavily populated Ebeye Island/Majuro Atoll is transported by inter-atoll transport vessel. The frequency of visits to each island is only once every three months. When the Project commences, commodities other than fresh fish can be transported at a rate of two times a month between Ebeye and the three outer islands by the introduction of the transport boat. With an increase in the frequency of transport, the people of these outer islands will be given an opportunity to increase their incomes, in addition to obtaining a stable supply of necessary daily commodities.

The Project has been concluded as appropriate for a Japanese grant aid program, as it is anticipated to contribute to Marshall Islands' foremost national objective of developing the outer islands and to contribute to improving the living standard of the people of Ebeye Island. However, in order to effectively and smoothly implement the Project, it is indispensable that the Government of the Marshall Islands take responsibility in implementing the following items:

1) Prior to Project implementation, MIMRA will be required to set up a supplementary operating fund in the amount of US$5,000 and to prepare an annual budget of US$12,000 as a supplementary fund to cover any future deficits.

2) Prior to Project implementation, MIMRA will be required to thoroughly explain to the people of the islands the basic Project contents, concrete implementing schedule, expected economic benefits, and required actions to be taken for the Project and to receive their understanding and cooperation.

3) MIMRA should select the essential and suitable personnel required for Project implementation.

   - One person in charge of collecting fish in each outer island
   - One captain, one engineer for the transport boat
   - One person in charge of fish sales on Ebeye Island
   - One person in charge of Project supervising

4) During the initial phase of Project implementation, MIMRA should bring in specialists in the field of fish distribution to realize appropriate and powerful management system.

5) MIMRA and related organization should compile and analyze fish catch data after the commencement of the Project and monitor resources in the Project areas. Based on that, MIMRA should formulate fishing regulations such as protected areas, closed season, mesh size of net, if it is necessary from viewpoint of resource management.

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1. INTRODUCTION

1. INTRODUCTION

The Republic of the Marshall Islands is striving to increase the incomes of the inhabitants of the islands by fostering a small scale fishery in the outer islands, and thereby rectify regional economic differences while establishing a stable supply of fish products to the consumption areas. In conjunction with these objectives, the Government of the Marshall Islands requested grant aid from the Government of Japan to provide basic facilities for development of outer islands' fisheries that would be capable of supplying inexpensive fish products.

On receiving this request, the Japanese government evaluated its appropriateness and significance and a basic design survey team was dispatched by the Japan International Cooperation Agency (JICA) headed by Masao Kishino, Research Division, Research Department of the Ministry of Agriculture, Forestry, and Fisheries to the Marshall Islands from April 8, 1991 to May 28, 1991. The survey team confirmed the background and objective of the request, explained the system of Japanese grant aid to relevant government officials of the Marshall Islands, and confirmed the undertaking by both governments. A survey was conducted on the social and economic conditions of the proposed Project area, the activities of the existing fishing industry, the distribution system for fish consumed, basic infrastructure, the suitability of the construction site, etc. The significance and appropriateness of the Project was deliberated before the basic design of the Project was formulated.

A draft final report mission headed by Kazuo Tanaka, Fisheries Insurance division, Fishery Agency was dispatched to the Marshall Islands for final explanation and discussion of the contents of the basic design report of the Project from August 4 to 13, 1991.

This report is the summation of the results of the aforementioned survey. Members of study teams, itineraries, and minutes of discussions are attached in Appendix 1.

2. BACKGROUND OF THE PROJECT

2. BACKGROUND OF THE PROJECT

2.1 Background of the Project

Although the Marshall Islands are surrounded by a wide expanse of ocean and is blessed with abundant fishery resources, domestic fish production remains undeveloped and fishing is largely limited to levels of self-sufficiency. In addition, the domestic fish distribution system is fragile, and techniques of handling and processing fresh fish are inferior.

Fish products are exceedingly important as a source of protein. In recent years, the population of salaried workers has increased along with a migration from the islands to urbanized Majuro and Ebeye Island, Kwajalein atoll. Consequently, Ebeye is no longer able to meet local fish consumption levels with the local production volume. Majority of the fish consumed volume on Ebeye is currently imported canned fish and it is one contributing element to the trade deficit. In addition to such conspicuous differences in fish consumption between the outer islands and the islands with an urbanized economy, there is a growing gap between the outer islands, dependent on copra production for cash income and the Majuro and Kwajalein atolls which are centered around a currency economy.

Against this background, the First Five Year Plan (1987-1991) of the Marshall Islands emphasized the importance of developing the economy of the outer islands. One means of developing the outer islands focused on revising the distribution of fish products between the consumption areas and the outer islands. The pilot project, "The Project for Local Fishery Development", was implemented at Arno atoll through an official grant aid from the Government of Japan. Upon completion of project facilities in 1991, project operations were commenced in Arno with the cooperation of OFCF. Under the Second Five Year Plan, the fisheries development program was expanded to include Ebeye Island in the Kwajalein atoll, the second largest consumption area. Focusing on the outer islands of Namu, Ailinglaplap, and Likiep which are the closest to Ebeye Island, a project to transport fish products from these islands to Ebeye was formulated with the objective of increasing the incomes of the outer island people by fostering a small scale fishery development to alleviate regional economic differences. The Project would establish a stable inexpensive supply of fish products to the consumption area. In order to assist with the plan, an official request was made to the Government of Japan for grant aid to provide the basic facilities and equipment for the project.

2.2 Outline of the Project

(1) Objective of the Project

The objective of the Project is to raise the standard of living in the outer islands and to narrow the urban/rural gap by enhancing income-generating fisheries through establishment of the most appropriate fishery related infrastructure.

(2) Project Sites

1) Likiep atoll, Likiep Island
2) Namu atoll, Namu Island
3) Ailinglaplap atoll, Airok Island*

*The survey team has concluded that Bouj district is the most suited site for the Project.

(3) Executing Agency

Responsible Agency: Ministry of Resources and Development
Implementing Agency: Marshall Islands Marine Resources Authority (MIMRA)

(4) Items requested by the Government of the Marshall Islands:

1) Fish landing facilities, equipment
2) Transport boat
3 Refrigeration facilities
4) Demonstration fishing boat
5) Fishing equipment

2.3 Outline of the Project Area

2.3.1 Outline of the Project Area

(1) Likiep Atoll

It is located approximately 220 km east-north-east of Kwajalein Atoll. Lagoon area is 424 km^2 and land area is 10.3 km^2. Most of the people live in Likiep Island which is located east-south-east part of the atoll. An air field for domestic air line is located in Likiep. This island has a history that coconut plantation was developed by German in the latter half of 19 century. The streets are lined with near rows of houses in the village and

this island has more generators and toilets facilities than the other atolls. Aquaculture of giant clams is being implemented by MIMRA at the neighboring island of Likiep Island.

(2) Namu Atoll

The atoll is located 74 km south of Kwajalein Atoll. Lagoon area is 398 km^2 slender elliptical shaped, and land area is 6.3 km^2. Most of the people live in four islands of Namu, Majikin, Mae and Loen. Air fields are located in Majikin and Loen islands. Each island in the atoll is small and no car was found in the atoll.

(2) Ailinglaplap Atoll

The atoll is located approximately 200 km south of Kwajalein Atoll. Lagoon area is 750 km^2 and land area is 14.7 km^2. Most of the people live in three islands of Airok, Wotja and Jeh. This atoll has the third largest population in the country followed by Majuro and Kwajalein Atoll. Air fields are located in the above three islands.

2.3.2 Socio-economic conditions of the Project Area

(1) Population

The population of the Marshall Islands is 43,380 according to the 1988 census. Much of the population (45 %) is concentrated in Majuro atoll, the capital, and in Kwajalein atoll (21 %) where the US military base is located. The population of the Project areas, Ailinglaplap, Namu, and Likiep atolls, are 1,715, 801, and 482, respectively. All three of these atolls suffer from a population drain to Majuro and Ebeye in Kwajalein, and their total population is increasing much slower than the natural rate due to out migration.

Population and Housing

	1980		1988	
Name of Atolls	Population	Household	Population	Household
Whole Country	30,873	3,871	43,380	4,923
Majuro	11,791	1,510	19,664	2,228
Kwajalein	6,624	652	9,331	950
Ailinglaplap	1,385	156	1,715	200
Namu	654	89	801	86
Likiep	481	63	482	71

Source: Census of Population and Housing 1988

(2) Economic Activities

Copra production and civil service are the main sources of cash income on the outer islands, followed by handicraft production. In addition, there are limited sales of fresh and salted fish to Majuro and Ebeye, but their percentage contribution to the island economy is small. This is due to their dependency on inter-atoll transport vessels and other ships to transport the fish. The cost of air freight is expensive. Even Namu atoll which is relatively close to Ebeye, can only ship their goods when ocean conditions are favorable. On Likiep atoll the pensions of retired public servants is a significant part of the cash economy

Source of Cash Income

Name of Atolls	Per capita Income from Copra (US$)	Paid Employment (Number of persons)	
		Public Sector	Private Sector
Majuro	13.0	1,934	1,846
Kwajalein	6.1	436	1,353
Ailinglaplap	88.7	86	18
Namu	77.4	47	3
Likiep	28.6	32	3

Source: Marshall Islands Statistical Abstract 1988/1989

(3) Food Habits

The traditional staple foods of the inhabitants of the oceanic islands, including Marshall Islands, is breadfruit, pandanus fruit, and taro root; while the major source of protein is fish. However, through trade, assistance, etc., economic ties between nations has become global and it is no longer possible for any nation to remain economically insulated. Marshall Islands is no exception and is now a part of the global economy. The consumption of rice and home made bread has grown not only in Majuro but in the other islands as well. In many cases, rice is eaten in the afternoon and evening. Since rice and wheat flour are imported, much of the cash income is spent on these two commodities. However, since cash income is limited, breadfruit is the staple food when in season. Moreover, in Ailinglaplap and Namu atolls the production of taro root has recently been revived.

(4) Basic Utilities

Drinking water is from rain catchment in the Project areas except for Namu atoll where well water comprises 30 percent of the drinking water. Many of the households in Ailinglaplap and Namu do not have toilet facilities unlike the homes in Likiep which all have toilets (mainly pit latrines), however in Ailinglaplap where a grant program by EPA is

constructing toilets and water catchments for all households. Much of the lighting is by kerosene lantern. However, in Likiep 20 percent of the lighting is furnished by electricity. In Ailinglaplap cooking is done by kerosene oil (57 %) and copra shell (37 %); and in Namu cooking by kerosene oil and copra shell is 16 and 83 percent, respectively. However, in Likiep 92 percent of the cooking is done by kerosene oil.

Basic Utilities

Unit: %

	Ailinglaplap	Namu	Likiep
Drinking Water			
Piped water	1.0	-	-
Rain catchment	88.5	70.9	95.8
Wells	4.0	29.1	4.2
Others	6.5	-	-
Toilet			
Flush toilet	2.0	-	2.8
Water seal	16.0	2.3	-
Pit latrine	11.0	14.0	97.2
None	70.0	82.6	-
Lighting			
Generator	5.0	-	22.5
Gas	0.5	-	-
Kerosene	94.0	100.0	76.1
None	0.5	-	1.4
Cooking			
Generator	3.5	-	1.4
Gas	2.5	1.2	2.8
Kerosene oil	57.0	16.3	91.5
Coconut shell	37.0	82.6	4.2

Source: Census of Population and Housing 1988.

2.3.3 Natural Conditions

(1) Climate

There is no data on the climatic conditions of the project areas. However, precipitation levels drop as one travels north from Majuro but remain similar to that of Majuro atoll according to the interview survey conducted in each atoll.

According to the climatological data collected at Majuro, temperature averages 27.3 °C and it is almost stable throughout the year. Annual precipitation is 3,400 mm. It generally tends to shower for short periods. Precipitation levels average around 200 mm during the months of January through March, but increase starting in April and reach a peak in October with around 400 mm per month The percentage of sunny days is greater than cloudy days throughout the year, and periods of continuously cloudy days rarely last longer than three days.

Stable trade winds blow from the east-northeast and the average wind velocity is 4-6 m/sec. However, the wind direction can change to southwest and the wind velocity become unstable from September to November. The highest wind velocity to date recorded on Majuro was a velocity of 23 m/sec.in January 1988.

Although damages related to cyclones are rare in Marshall Islands since the atoll is not located in a development route of typhoons, all the houses were destroyed in 1958 on Jobwor in Jaluit due to a heavy rainstorm; a flood tide was recorded in 1979 in Majuro; and as recently as in 1988 several houses on Ebeye were destroyed in a heavy rainstorm.

(2) Oceanography

1) Tide Fluctuations

Tide measurements were taken with a tide gauge for approximately 15 days from April to May 1991 at the west channel of Airok island of Ailinglaplap atoll and the lagoon side of Majikin island of Namu atoll. The measurements and a figure of the tide fluctuations based on an analysis of tidal harmonic constants are given in the Appendix 3-1.

The highest high water level was 181 cm at Ailinglaplap and 184 cm at Namu.

2) Wave Conditions

The largest waves observed in the waters among the outer islands were approximately 5-6 meters in height in mid-ocean and 8-12 sec. in wave period; and steep waves were also observed.

In general the waves near the project areas were comparatively calm on the down wind side of the land due to the trade winds which blow from a constant northeasterly direction.

In Likiep, since the project site is located on lagoon side of the island and is protected by land, waves in front of the site are quite calm. In Namu and Ailinglaplap, the sites are also located on the down wind sides of the islands and the waves are calm. However, when the winds blow from the opposite direction during September through November, significant waves are generated.

Topographically, the Ailinglaplap site faces the channel interconnecting the lagoon and the ocean, and is affected by the waves from the open sea when strong winds blow from a southwesterly direction. The Namu site is affected by wind waves generated in the lagoon when strong southwesterly winds blow.

3) *Ocean Currents*

In the ocean of higher latitude above Namu atoll, the North Equatorial Current flows from east to west at a speed of 0.5-1.0 knots. In contrast the North Equatorial Counter Current flows from west to east in the southern waters below Namu, but the current between Namu and Ailinglaplap appears to be not so strong.

The water currents surrounding the Project site were measured using a mark buoy at Namu and Ailinglaplap and the results are given in the Appendix 3-2. It was observed that the current flow at Namu ran southeast to northwest, parallel to the shoreline in front of the site. It was slow and stable at approximately 0.1 to 0.17 knots, irrespective of the ebb and flow of the tide.

4) Soil Conditions

A standard penetration test at a depth of about ten meters was conducted at one or two points on the sites at Likiep, Namu, and Ailinglaplap; and together with a laboratory analysis, the nature of the soil was evaluated and the results have been given in the Appendix 3-3.

In general, the geology of the sites is layered sand containing coral gravels, and is comparatively soft below a depth of five meters. In contrast, the reefs and the surrounding shallowing areas are covered by a hard cemented layer.

At the site in Likiep, no rocky layers were found, but the surface was covered by gravel and sandy layer to the depth of 1-2 meters. Sandy layers and gravel layers are found alternatively below the depth of 2 meters.

At the site in Namu, sand with some gravel covered the surface to the depth of 3 meters at both point of land side and sea side. Below 3 meters depth, a layer of coral rocks 1-2 meters deep was found at land side and a sandy layer found was at sea side.

The soil of the Ailinglaplap site is composed of cemented gravel one to three meters in depth with a layer of sand and gravel beneath. The soil on the ocean side is particularly cemented.

5) Sand Drift and Erosion

The Project sites, with the exception of Namu, appear to have stable shorelines. Based on an interview survey of the area, the general consensus is that shoreline formation is stable. However, changes in shoreline have been established from aerial photographs of Majikin in Namu. From the field survey, it was discovered that the

shoreline of the island bordering the lagoon near the airport has begun to erode. Dredging which was carried out during construction of the airport may be the cause; however, a thorough investigation of the situation has not been conducted. As delineated earlier, a weak but stable current runs parallel to the shoreline; therefore, construction of structures on the beach must be planned with due consideration.

The sea bottom at the Likiep site was sandy below the lower low water level and there are comparatively steep slopes. During the survey, there was very little wave action and just below the surface of the sand bottom at a water depth of one meter blackish sand was found, which indicates a lack of oxygen. Therefore, there does not appear to be a significant movement of sand.

At the Ailinglaplap site hard reefs extend out toward the channel for about 60 meters. The island is composed mainly of gravel and reefs, and sand is found only at the bottom of deep channels off the reefs and on the shoreline of the lagoon side. Sand rarely accumulates on the reef, even in the access channel, or in natural crevasses. It is believed sand is washed out to deeper channels with the ebb and flow of the tide.

As can be deduced from the aforementioned, the construction of landing facilities may seriously affect sand drift and erosion at Namu Project site. Unfortunately, there is very limited data on sand drift and erosion to conduct detail analysis. Therefore, efforts will be made to minimize any possible adverse effects of construction on the environment at Namu as well as at Likiep and Ailinglaplap. It will be necessary to monitor the environment after construction has been completed.

2.3.4 Present Conditions of Basic Infrastructure

(1) Basic Infrastructure

Electricity, water, and roads are well maintained in the capital, Majuro, and on Ebeye Kwajalein atoll; and public facilities such as government offices, port authority, hospitals, schools, churches, etc. as well as hotels, stores, commercial offices, etc. are concentrated in these two locations. During the field survey, there were no incidents of electricity blackouts or electrical power shortages except for periodic maintenance and repair; and electricity appears to be well maintained. There are paved two-lane roads and transportation by private cars, minibuses, taxis, etc. from the DUD region to Laura region on Majuro and on Ebeye

However, electric power and paved roads are nonexistent at the three Project areas of Likiep, Ailinglaplap, and Namu. Moreover, communication between each island and

Majuro and Ebeye is by privately owned SSB or SSB available at the medical clinic of each island.

Basic infrastructure conditions on each island surveyed are shown as follows:

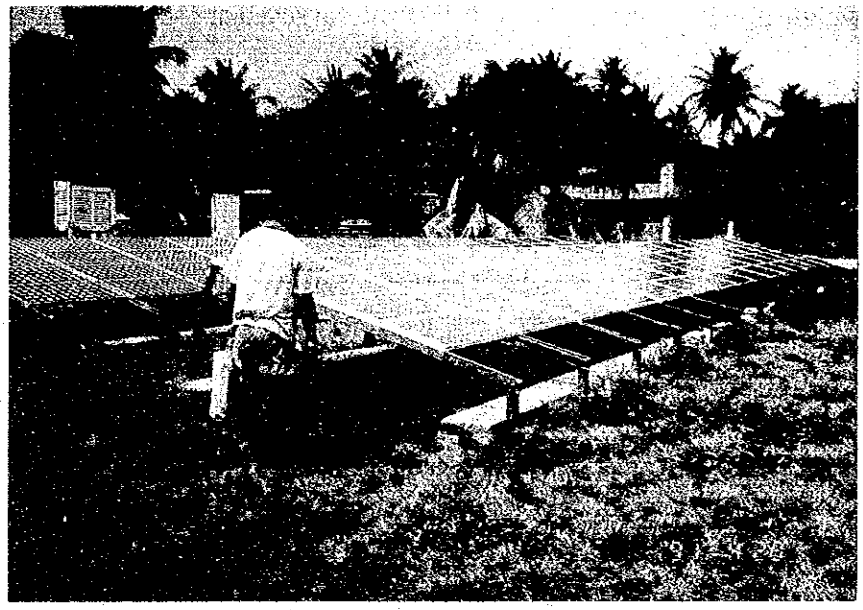
Area	Transportation		Electric Power				Water		Communication
	Road	Vehicle	Power Plant	Solar Battery	SmallGen-erator	Water Works	Rain Catch-ment	Well	
Majuro	Paved	Many	O	-	O	O	-	-	Public phone Satellite SSB(-)
Ebeye	Paved	Many	O	-	O	O	-	-	Telephone Satellite SSB(-)
Likiep	Non-paved	Many	X	O	O	X	M	O	SSB(3)
Namu (Majikin)	Non-paved	None	X	O	O	X	O	O	SSB(2)
Ailinglaplap	Non-paved	3	X	O	O	X	O	O	SSB(2)
Utrick	Non-paved	3	O	O*	O	X	M	O	SSB(2)

Remarks: O = Constructed; M = Under Construction
X = Non-existence; - = Not surveyed
* = Electricity is supplied to the village by solar power system in Utrick Island.

(2) Present Condition of Power System

Through the assistance of the USAID, electric power is supplied by solar power system on the Utrick island. An outline of the solar power system is given below.

Generator facility:	Solar collector (600 x 1220) x 120 panels Battery 120 units (Total power: 11.5 kwp)
Power Distribution facility:	Electricity is supplied to private households from the distribution panel on the city roadsides, which is in turn, supplied through underground lines from the distribution board at the power plant.
Power supply:	70 percent of all private homes (101 households) utilize interior fluorescent lighting (20W x 2-4 lights). Fans and refrigerators utilized by public facilities (150 liters x 6 units)
Operation:	1982 - present
Management:	Local government of Utirick Island and the Department of Energy (DOE)



Solar Power System in Utrik Island

The solar power system was introduced in 1982 and maintained by Marshallese engineer who was trained by U.S. Contractor. It has supplied electricity without any major problems for approximately nine years. However, due to deterioration of the batteries, the system had not been in operation since February 1991 until the time of this survey in April 1991. According to the manager in charge of maintaining the system, increased demand due to lighting in each home caused parts of the solar battery to over-discharge and hastened its deterioration. Plans to repair the system are currently underway within the Department of the Interior and budget allocation is being deliberated. In view of the fact that a solar energy system has successfully operated for nine years, utilizing such a system for the Project should be seriously considered in order to minimize running costs.

(3) Construction Conditions

The two institutions responsible for implementing public works are the Ministry of Public Works and the Capital Improvement Project Office (CIP). The former is responsible for maintaining roads and other public facilities, and leasing construction equipment, while the latter, under the jurisdiction of Marshall Islands Development Authority (MIDA), is responsible for design, tendering, and supervision of construction.

Major private construction companies include Pacific International, Inc. (PII),

McConnel Dowell, Robert Reimers Enterprises (RRE), United Atoll General Contractor, etc.

Construction equipment currently in use belongs mainly to PII or the Ministry of Public Works. However, much of the equipment owned by the Ministry of Public Works is either under repair or inoperable. As a result, machines which can be used, are limited. The following is a list of major equipment which is available.

- Concrete batching plant
- Crawler crane
- Truck crane
- Vibro-pile crane
- Diesel pile hammer
- Rock drill
- Agitator truck
- Landing craft, etc.

Construction workers are comprised of Malaysians, Filipinos, Americans, New Zealanders, etc. The majority of the Malaysian workers are ordinary laborers, the Filipinos are are the skilled workers, while the remaining foreign workers are employed as foremen, construction engineers, and project managers. Wages in the private sector are higher than wages in the public sector.

Construction materials which are available locally are limited to aggregates such as coral sand, gravel, and concrete blocks (cement is imported). The rest of the materials are all imported. Imported materials currently in stock is given below. However, the quantities on hand are insufficient for the Project and additional supplies must be imported.

- Cement (Korea)
- Wood and plywood materials (USA)
- Iron reinforcing rods (Korea)
- Roof materials (USA, New Zealand), etc.

2.3.5 Fisheries in the Project Areas

(1) Outline of the Fisheries in the Outer Islands

An interview survey was carried out on Likiep, Namu, and Ailinglaplap atolls. Fishing methods were all similar in these islands; and data on major fishing methods, fish catch, etc. were compiled into the following table.

Fishing Method	Fish Species	Fishing Grounds	Catch Volume	Remarks
Hand line	Reef fishes	Lagoon	9-45 kg	Common
Trawling	Tunas	Ocean	23-45 kg	Affected by sea conditions
Drive-in net	Shoal fishes as goat-fish	Lagoon	45-136 kg	Joint operation by 10 persons
Floating gill net	Reef fishes, migratory fishes	Lagoon	90-227 kg	Joint operation by 10 persons
Cast net	Shoal fishes as small mackerals	Shore side	4-23 kg	
Spear	Reef fishes	Reef	23-68 kg	Big catch at night
Light attraction	Flying fish	Ocean	23-136 kg	Depending on sea conditions

Hand line is the most common form of fishing. It is usually carried out on the reefs or near their edge. Fishing grounds where large volumes of fish can be caught are concentrated in several spots. In water not exceeding 100 meters in depth, a wide variety of reef fish such as snappers, groupers, surgeon fish, etc. are caught.

Pelagic fish such as tuna, dolphin, wahoo, rainbow runner, etc. are harvested by trolling. Although fishing grounds differ among the atolls, they are generally located on the ocean side. Although trolling by fishing boats with outboard engine is more effective in harvesting a larger volume of fish than by canoe, fuel consumption is quite high.

Shoal fishes such as goat fish are commonly caught by drive-in net fishing. This fishing method is common on the lagoon side of the atoll within 100 meters of the shoreline. Fish are driven toward the shore by about ten people using sticks and coconut leaves.

Fish caught by floating gill nets are surgeon fish, trigger fish, snappers, and other reef fishes. This method employs a floating gill net of about 20 to 50 meters long and the fish are driven into the nets by about 10 people swimming. It is usually carried out in slightly deeper waters around the edge of the reef on the lagoon side of the atoll.

Spear fishing is carried out near the reefs by either diving or directly from a boat using a two meter long spear to pierce the fish. It is often conducted at night using underwater lights since the volume of fish harvested is larger at night than during the day.

Fishing by light attraction is carried out at night using lanterns, torches, and small scoop nets to catch flying fish. Fishing season is from early summer to autumn

Cast net fishing is carried out near the shoreline in shallow waters and horse mackerel, goat fish, and mugil are commonly caught.

Fishermen use various methods according to ocean conditions and fish movements. Although catch volume differs largely depending on the time and the situation, data based on interview and actual catch volumes weighed during the survey was used for the above table. Generally, at an interview survey, respondents exaggerate their catch volume without considering their unproductive fishing days. Therefore, the fishermen were asked to give the minimum volume of fish caught on any given day. Despite this, the average catch volume (mainly hand line and trolling) was high in comparison to the case in Arno.

Spear fishing, fishing by light attraction, and trolling are highly effective fishing methods but favorable fishing times are limited for trolling and light attraction since those fishing methods are dependent on sea conditions, fish movements, etc. In addition, fishing by drive-in nets or floating gill nets requires the joint effort of ten people; and although the volume of fish harvested at one time is large, when the catch is divided among ten people, it is only 9 to 23 kg per person.

Fishing is considered a man's job and it is common for children to begin fishing by hook and line or by spearing fish. However, fishing independently by canoe usually begins around age 15. Most of the fishing boats are canoes without out-rigger which vary from one-man canoes about three meters long to five man canoes about seven meters long. However, the majority of the canoes are small and compact. Many canoes can be equipped with sails, but do not go out very far. In addition, there are a small minority of fishing boats with outboard motor of 20 to 110 horsepower. However, due to high fuel costs, these boats are used infrequently. Most of the fishing boats are operated within an hour's distance from the fishing village.

Fishing is conducted two to six times per week, and differs by fishermen. With the exception of Sundays, if the ocean conditions are favorable, fishing boats will go out and normally catch enough fish for the consumption of that day or the following day.

Families which own one small canoe and have several adult males, will occasionally send out two persons in one canoe. However in many instances, the boys appear to take turns in using the canoe. If the volume of fish caught by each family is limited to one or two days food supply, one person should be sufficient. Since boats and fishing gears are limited in number, such equipment is often borrowed from fishermen who have them.

The number of fishing boats and males over the age of 15 at each island where the Project sites are located, are given below.

	Number of Boats		Males Over 15 years	Total Number of Persons on Boats
	Canoe	Outboard		
Likiep Likiep	4	15	90	49
Namu Majikin	20	1	44	23
Ailinglaplap Airok	80	7	152	87

Assuming that one canoe with one fishermen and one engined boat with three fishermen, depart simultaneously and that the minimum fish catch volume per day is about 10 kg per person (about 20 lbs), the fish catch volume was estimated as follows: Likiep, 490 kg; Majikin, 230 kg and Airik, 870 kg.

Since fresh fish which is sold in the market must be caught within a relatively short period of time (within two days) in order to be transported fresh to Ebeye, spear fishing which is a highly effective fishing method for ensuring stable and high volume fish catch, should be conducted in this Project. A minimum fish catch of 25 kg (about 50 lbs) per person is estimated for spear fishing.

(2) Present Conditions of Fish Marketing

Fish caught in outer islands are for self-consumption, and the catch volume is sufficient as source of protein. Fish caught on one fishing trip in one hour of fishing, depending on the day, fishing method, technique, and experience averages from several to 20 fish per fishermen, and this volume is adequate for one or two meals. When fish is caught in large volumes, it is distributed to friends and relatives, or preserved by drying, salting or smoking.

In contrast, it is seldom that fishermen earn a living only by fishing in the urban areas of Majuro and Ebeye. Although there are some people who fish on the weekends, supply falls a long way behind demand.

Under these circumstances, some inhabitants of the outer islands transport dried or salted fish by inter-island ferry which arrives once every three months or by air to Majuro and Ebeye. The fish are, in turn, sold by their friends and relatives.

Although fish price differs according to size and species, one fish weighing 500 g to 2 kg in product weight (equivalent to one to four kilogram in raw weight) sells for

approximately US$0.60 to $1.00 (including transport costs). However, the volume of fish distributed to the market in Majuro and Ebeye by this method is quite small and unpredictable and has not as yet developed into a meaningful source of revenue for the outer islands.

2.3.6 Consumption of Fish Products on Ebeye Island (Kwajalein Atoll)

(1) Socio-economic Conditions

Ebeye Island is located in the southeastern part of Kwajalein atoll and is a small island with a land area of 0.32 km^2. Inhabitants were moved to this island from their home islands in the atoll in the early sixties due to the missile experiments conducted at this atoll by the United States. In addition, the island's population increased rapidly from several hundred to several thousand from the 1950's to the 1960's when many inhabitants from other islands immigrated, attracted by the opportunity to earn cash by working on the army base. In recent years the population has grown at an annual rate of 4.2 percent from 1980 to 1988; and in 1990 the population was estimated to be 9,600. There are approximately 950 households. Coconut trees are scarce on this island which is said to have the highest population density in the world; and it is rapidly deteriorating into an urban slum.

The number of people employed on the US military base in 1990 was 800, excluding foreigners, and the number of public servants employed by local government was 181. This is equivalent to one person per household who is an income earner. Moreover, since there are many private industries and retail stores on the island, families which are partially self-sufficient, as seen on the other islands, do not exist on this island.

(2) Consumption of Fish Products

The staple food is rice, the same as on the outer islands. A major source of protein is imported meat/poultry (frozen) and canned food. The consumption of fresh fish is low. Data on the consumption volume of meat/poultry, canned food, and fresh fish on Ebeye Island was estimated from an interview survey of importers, retailers, and consumers and is shown below.

	Imported Volume (tons)	Per Capita Consumption Volume (kg)
Frozen meat	840	88
Canned meat	220	23
Canned fish product	120	21
Fresh fish	0	14
Salted/dried fish	0	unknown
Total	1,180	146

In the interview survey, a large number of people reported going fishing on the weekends (Saturday) to catch their own fish. It is estimated that the total number of fishing boats is about 30 to 40, with the majority being outboard motorboats from 10 hp to leisure boats of 100 hp. Those without boats are either given a ride or fish on the shore with hook and line or cast nets. When large volumes of fish are caught, they are either shared with friends or sold to restaurants, small groceries, or supermarkets. However, there are no inhabitants who earn a living only from fishing on Ebeye.

When asked what was the favorite source of protein, all of the families in the interview survey responded with fresh fish as their first choice; and their desire to eat fresh fish was high. Although meat, canned food, and milk is served in school lunches as a source of protein, fresh fish is hardly ever served. School lunch programs are regulated by the Ministry of Social Service and the volume of food for one lunch per person is as follows:

Meat	84 g
Fruits/Vegetables	168 g
Starch (rice/bread)	168 g
Milk	180 cc

Fresh fish is preferred by the children and the Ministry of Social Service has expressed its desire to introduce fresh fish two to three times a week in the school lunch program.

There are 35 grocery stores, including supermarkets, which sell food products and each store has one to three refrigerators/freezers which are used to preserve meat, fish, and ice cream. However, there were only four or five stores selling fish during the field survey.

(3) Estimated Demand for Fish Products

According to the interview survey conducted on Ebeye, fresh fish is currently consumed once a week by either catching the fish oneself on the weekends (Saturday) or purchasing it at the store (fish caught locally). Fish is usually boiled, baked or fried. The consumption volume varies among families; on an average, a household consisting of five family members consume one fish weighing about 1.4 kg (3.0 lbs) at one time, and in case of household of 10 members two fish of same size is consumed (fish in Ebeye is smaller than fish in outer islands). Therefore, the daily average per capita consumption is 270 g (0.6 lbs), and this is equivalent to an annual per capita consumption volume of 14 kg.

The demand for fresh fish is high in comparison to meats and canned food, and many of the inhabitants appear to be dissatisfied with the shortage of fresh fish. The retail price of fresh fish caught on the weekends is US$3.30 per kg ($1.50/lbs) and is high in comparison to the price of chicken which is US$1.76 per kg ($0.80/lbs). Despite this fact, fish is sold quickly , which shows the high demand for fresh fish.

In surveying the potential demand of each family if fresh fish were in ample supply, the majority responded that fresh fish would be eaten three to six times a week. In discussions with the families surveyed, it was found that although it is their desire to eat fish daily, as in the outer islands, many responded that they would limit their consumption of fish to three times a week, since chicken which is currently the main source of protein, is much cheaper than fish.

Assuming the potential demand for fresh fish is three days a week and the daily consumption volume is 270 g/person, the total population of Ebeye (9,600) would consume approximately 7,780 kg of fresh fish per week or 400 tons annually. In conjunction with the current estimated annual consumption volume of 21 kg of canned fish (raw fish count), the total annual consumption volume of fish products is about 61 kg/person. This is nearly equivalent to the annual fish consumption volume of 65 kg (FAO, 1979-1981) of Kiribati. In actuality, a segment of canned fish consumption would be substituted; and therefore, the consumption volume of fish products would be lower than this figure (refer to Appendix 4).

The average fish demand on Ebeye is 1,110 kg per day. Considering the rapid deterioration of fresh fish, it is desirable that the volume of fresh fish transported from the outer islands be limited to less than 1,110 kg. Moreover, since an estimated 2,600 kg of fresh fish are caught and consumed by the inhabitants of Ebeye Island on Saturdays and Sundays, fresh fish transported from the outer islands should be limited to the weekdays, from Monday to Friday.

(4) Actual and Potential Sales of Fish at the Stores

The data collected from an interview survey on present conditions in the sale of fresh fish and the potential volume of fish which can be sold at the major supermarket Robert Reimer Ent. (RRE), and at 35 other grocery stores is summarized as follows:

1) R.R.E.

On the average, about 230 kg (500 lbs) of fresh fish is purchased on the weekends by the supermarket which is displayed in the refrigerated show case and the fish is completely sold out within two days. A stable volume of fish cannot be secured. If a stable volume of fresh fish can be procured, the supermarket will easily be able to sell 230 kg of fresh fish daily.

2) Other Food Stores

There are a total of 35 other grocery stores on Ebeye and each store is equipped with a refrigerator or chest freezer. During the field survey only four stores were selling fish and they sold approximately 45 to 90 kg per day. The remaining 31 stores have all sold fresh fish in the past, and according to the interview survey, each store would be able to sell at least 45 kg (100 lbs) of fresh fish per day.

The potential volume of fresh fish which can be brought in from the outer islands and sold in Ebeye is 230 kg per day for RRE; and for the remaining 35 grocery stores, if all were contracted to purchase fresh fish, the calculation would be 35 stores x 45 kg x 0.5 = 790 kg. Therefore, taking into consideration the ability of these stores to sell fresh fish, it is necessary to limit the total volume to 1,000 kg per day.

3. PROJECT CONTENT

3. PROJECT CONTENT

3.1 *Objective of the Project*

The objective of the Project is to lessen the economic gap between the urban area and the outer islands by developing the fishery on outer islands from self-sufficiency to a commercial level capable of generating cash revenue. The Project will help to establish periodic transport and sales of fish products from outer islands to Ebeye where the population is concentrated, by installing basic facilities and equipment required to promote the fishery into a source of cash revenue.

3.2 Content of the Request

3.2.1 The Appropriateness and Necessity of the Project

(1) Appropriateness of Project Content

Presently, the main source of income of outer island economy centers on copra, followed by civil service salaries, and handicrafts. In contrast, daily commodities such as rice, clothing, kerosene oil, etc. are imported. Recently, the flow of cash income has been sluggish due to the drop in the international price of copra. By utilizing the islands' fish resources as a source of cash income, the Project will play an important role in cultivating and supporting the islands' financial base.

The three atolls; Likiep, Namu, and Ailinglaplap were selected as the project sites which will supply fish to Ebeye. Appropriateness for the selection of these atolls is based on the following view points.

1) The National Plan

The Second Five Year Plan (1991/92-1995/96) is currently being prepared. According to the draft of fishery development plan under the Five Year Plan, seven outer islands have been pinpointed as areas where immediate development measures must be taken. The three islands in this Project are among them, and are located the closest to Ebeye of the seven. In particular, per capita income earned from copra on Likiep atoll is low; and due to the potential of the Project to propagate to the northeastern atolls of Utirik, Taka, Ailuk, etc., Likiep was given high priority as an area to be developed.

2) Project Effect and Ability to Implement the Project

A comparison of Project effect on the three islands and their ability to implement the Project was compiled into the following table.

Evaluation Index	Likiep	Namu	Ailinglaplap
1. Atoll population	482	801	1,715
2. Direct beneficiaries	482	530	794
3. Fishermen population (male aged 15-65 years)	109	104	139
4. Transport distance of fish products (nautical miles)	120	40	110
5. Number of experienced technical trainees	10	1	2
6. Propagation to other islands (within 100 nautical miles)	4	0	0

Note: Transport of fish from islands within the atoll which are more than 15 nautical miles away is too time-consuming and therefore, they were excluded as beneficiaries of the Project.

Ailinglaplap has the greatest number of direct beneficiaries in terms of population among the three islands. However, Likiep is the most promising in propagating the effects of the development program to other islands, since Namu and Ailinglaplap are geographically isolated. In terms of transport distance, Namu is one third the distance of the other two islands and has an advantage. The population of fishermen who will join the project on the three islands are about equal, but Likiep has the largest number of experienced technical trainees needed for maintenance and control of boat machinery, generator, etc.

According to the above analysis, all three islands have both advantages and disadvantages, but in terms of the ability to implement the Project, there appears to be no conspicuous differences.

3) Fish Resources

In order to achieve the Project objective to transport and sell fresh fish from the islands to Ebeye, it will be necessary to catch the fish in a relatively short period of time (two days) to maintain quality control. Consequently, possible sales volume from each island will be limited. In order to make the Project viable economically, each island must catch four to five tons of fish per month to cover maintenance and operating costs, which may have serious effect on fish resources.

Although there is no reliable data on the volume of fish resources in the coastal waters of the atolls, based on the data compiled from surveys carried out on the atoll of Enewetak

in Marshall Island, American Samoa, and the Philippines, an annual optimum yield is estimated at 4 -27 tons per km^2 (U.S. Department of Energy, 1987). Coastal atoll waters which show fairly high productivity are limited to areas near the reefs or knolls, though some differences exist from region to region. Consequently, as a whole, fish resources is not very abundant.

An optimum yield of fish within 15 nautical miles from the Project site along the coast on the lagoon side (the usual fishing grounds) is estimated at 44 to 300 tons using the aforementioned data (assuming the width of the reefs along the shore averages about 200 meters). The population along the coast is about 482 to 794 people. Assuming that the annual fish consumption volume is 100 kg per person, the annual volume of fish harvested for self-sufficiency is estimated to be 48 to 79 tons. Therefore, an ample surplus of fish resources may not exist even when the unstable fish catch near the reefs on the ocean side, which is affected by ocean conditions, is taken into consideration. In order for the Project to remain stable and financially viable, covering the transport and sales costs, including maintenance of the boat, it was estimated that 50 tons of fish products would have to be handled annually. Subsequently, it was recommended that fish products should be collected from at least three atolls in order to keep the negative impact on fishery resources to a minimum.

There are many unproven assumptions for the fish resources analysis. In addition, large differences exist due to the special characteristics of each island. Therefore, the aforementioned estimated volume contains many indeterminate factors. However, gradual development of resources should be carried out in conjunction with monitoring of resources, in order to avoid dealing the fish resources of any island a lethal blow by rapid concentrated development of this limited resource.

Therefore, based on sections 1), 2), 3) delineated above, it was judged appropriate to implement the Project targeting the three islands requested.

4) Construction of Fish Landing Facilities and Its Effects on Live Coral and Fish Poisoning

According to an underwater survey of the newly completed jetty and water channel at Arno and Ine in 1990, no damage to live corals was not found with the exception of corals within a few meters of the area which was excavated by blasting. It is generally known that corals are destroyed by direct causes such as explosions and indirect causes such as the accumulation of mud, sand, etc. which shut out the sunlight required for photosynthesis. According to the underwater survey, accumulated sediments were not observed on corals in the area. Therefore for the current Project, if blasting is limited to the some degree,

damage to live corals will be very limited. However, although excavations may have minimal impact on the corals at that time, there may be a serious aftereffects to coral over a longer period. Thus, it is recommended that continuous monitoring by diving observation be carried out in the future.

A common form of food poisoning by fish, found within the tropical waters of Marshall Islands, is Ciquatera poisoning. This form of food poisoning occurs when fish which has accumulated the Ciquatera poison through eating poisonous seaweed, is ingested. Although it is commonly known that food poisoning occurs when a lot of fish which feed on the poisonous seaweed is consumed, it is difficult to pinpoint the phenomenon in terms of locality, the degree of poisoning by season and fish species. In many cases, the phenomenon differs even within the same atoll; it is sometimes different between ocean side and lagoon side in the same island. The survey found that the southern part of Namu island, including the Project site, has comparatively few poisoned fish.

In addition, it is sometimes reported that fish become poisonous when the water environment changes for example due to construction of off-shore facilities. According to an interview of the specialists, although this phenomenon is known, there has been little concrete research undertaken on the subject. It was their opinion however that there are instances when poisonous seaweed proliferate on reefs destroyed by construction or on the surface of structures which have been built on the ocean. According to the interview survey at Arno, this phenomenon of fish poisoning has not been observed. However, it is necessary to conduct continuous interview survey on this phenomenon, including the current Project sites after the facilities have been completed.

(2) Benefit of the Project

At each of the three targeted atolls of Likiep, Namu, and Ailinglaplap an annual catch of 16.8 tons of fish is expected, which is equivalent to approximately US $50,400 in production. It will be equivalent to 60 percent of copra production at Likiep, 14 percent at Namu, and 6 percent at Ailinglaplap. Per capita income for the fishermen around each site (aged 15 to 65 years) will be US $77, $81, and $60, respectively which is nearly equivalent to the income earned in copra production. In addition, the transport boat will transport needed daily commodities on its return trip to the islands and its effect on the social economy will be large.

On the other hand, the supply of fresh fish will substitute a segment of imported canned fish in Ebeye and thereby, conserve foreign currency. If 50 percent of the volume of fresh fish (converted raw fish) supplied to Ebeye was able to substitute the equivalent volume of canned fish, it would be possible to conserve US $36,000 annually in foreign

currency as shown by the following equation.

50,400 kg x 0.5 x 0.53 (conversion rate) x US$2.70/kg (import price)
= US$36,000

Therefore, based on the above, it was concluded that Project implementation was meaningful due to its highly beneficial effect on the social economy.

(3) Project Scale and Viability of Management and Operation

1) Possible Sales Volume in Ebeye

When fish is transported from the outer islands to Ebeye, the possible sales volume of fish products, as explained in section 2.3.6, and excluding the volume of fish caught on Ebeye for self-consumption, is 1,110 kg per day which can only be sold Mondays to Fridays. In addition, the grocery stores on Ebeye are only capable of selling about 1,000 kg per day. Consequently, the volume of fish to be transported should be planned not to exceed 1,000 kg per day.

2) Possible Fish Yield on the Islands

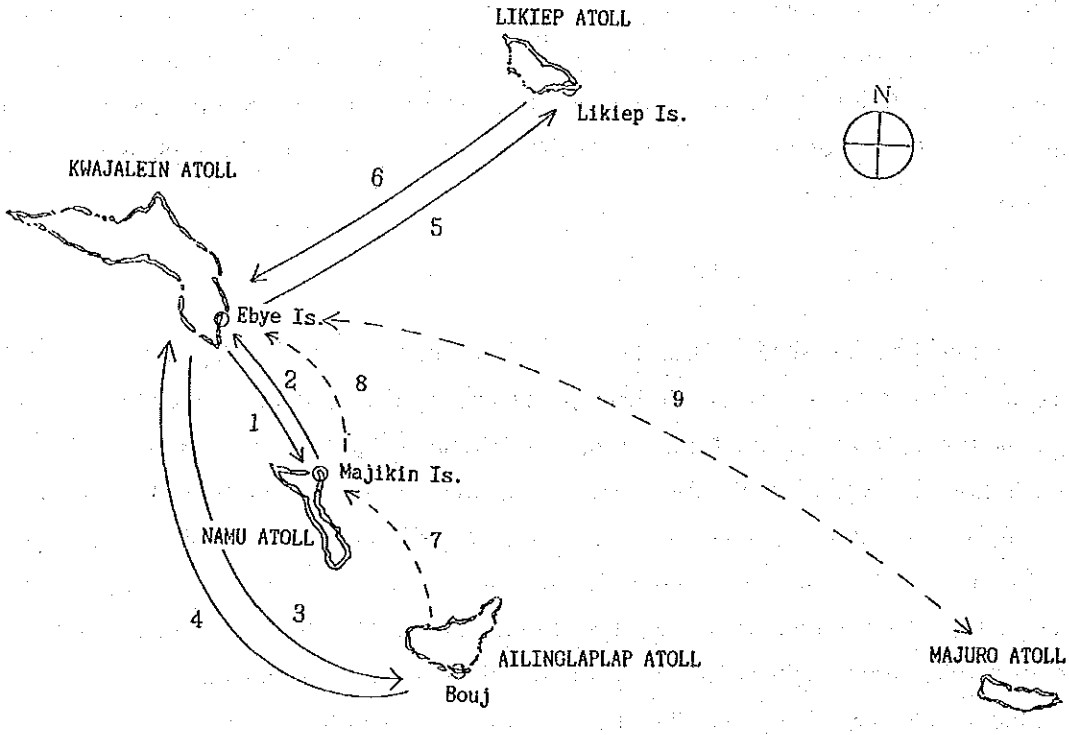
As explained in section 2.3.5 the catch of fish fluctuates greatly depending on the ocean conditions at the time. If ten fishermen using the fishing boat supplied by the Project operate for two days, the minimum volume of fish harvested should be 450 kg (1000 lbs). In addition, 250 kg (about 500 lbs, the lowest estimate of fish caught in one day by all the fishing boats around the Project site) can be anticipated from existing fishing boats. It has been estimated that the lowest volume of fish which can be harvested in two days will be 700 kg (about 1,500 lbs). However, it is essential that fishermen understand and adhere to the fish collection schedules. If a large volume of fish cannot be anticipated due to weather or other conditions, a portion of the previous days catch should be processed and used to fill in the anticipated shortage.

3) Transport Schedules

Generally fish packed in ice will maintain a relatively good degree of freshness for a maximum of seven days. Therefore, two days will be spent harvesting the fish, one day for transport, one day for sales, three days for reserve (when transport is delayed, or when stores have unsold fish) is recommended. In the case of Likiep which is located the farthest from Ebeye (120 nautical miles) among the three atolls, the transport boat which has a speed of seven to eight knots will be able to make a one way trip in 20 hours even under strong wind and waves.

The transport route from each island to Ebeye should be as shown on the following map from a viewpoint of fish quality control.

Each island has transported fish products by air or by Microship, but this is the first time that they will have transported fish for sale by transport boat. At the start of operations, fish will be transported once a month from the islands. This will eventually increase to twice a month. When the transport boat visits each island twice a month, fresh fish will be transported to Ebeye six times a month.



The Route of the Transport Boat

DAYS														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R1	C	R2	S	F	R3	C	R4	S	F	R5	C	R6	S	F

R1~6: Indicates the Routes 1~6 in the above figure.
C: Collection of fish, S: Sales of fish at Ebeye, F: Fueling

The transport boat will travel in order of routes 1 to 6 from its base in Ebeye. When fixed fish volumes cannot be collected from Namu and Ailinglaplap, the transport boat will proceed to take rout 7 and 8 in stead of 4. Route 4 should be used as a rule in order to maintain fish freshness and efficient collection. The transport boat will travel route 9 once a year for maintenance and repairs.

4) Cost Performance of the Transport Boat

A transport boat approximately 15 meters in length run by an engine with 100 horsepower is considered suitable in terms of cost performance. Cruising speed is 7.5 knots and a round trip to the furthest island, Likiep which is 120 nautical miles from Ebeye, will take approximately 40 hours due to such factors as ocean current, wind, waves, etc. Average volume of fuel consumption is estimated at 25 liters per hour and 1000 liters of fuel will be consumed for one round trip to project site. Fuel cost on Ebeye (government price) is US $0.27 per liter. Therefore, the fuel cost for one round trip is estimated at US $270. Maintenance and control costs is estimated at an average of US $300 per month and US$3,600 per year which includes engine overhaul, piston ring, nozzle, exchange, for every 5000 hours of navigation, machine oil and fuel filter exchange for every 500 hours of navigation, and engine oil and oil filter exchange for every 250 hours of navigation.

5) Required Personnel for the Operation

Personnel required for Project operation include one person on each island in charge of fish collection, two persons to operate the transport boat (the captain and engineer), and one person in charge of fish sales on Ebeye. However, in future when the transport boat increases the number of trips to each island, it may be necessary to rotate boat operations personnel with another team of operators.

Personnel in charge of operations on each island will be responsible for keeping in close contact with Ebeye and with the transport boat to ensure that fish is collected in time for shipping schedules. They will collect the planned volumes of fish, weigh-in, properly pack in ice to guarantee quality control in terms of fish freshness; and they will be in charge of maintenance and management of the facilities. The personnel in charge of fish sales on Ebeye will be responsible for maintaining close contact with each island and the transport boat while overseeing sales contracts with each grocery store and other duties related to sales with the cooperation of the local wholesalers.

6) Ice Required for Maintaining Freshness

According to interview survey it is noted that the preference for fresh fish is stronger than frozen fish due to traditional food habit in the Marshall Islands. Therefore, the fish will be packed with ice for distribution. Presently, ice is made by freezer, freezer container, and a small ice making machine in Ebeye. Despite this, the volume of ice produced is still insufficient to meet current demand for ice on Ebeye. Subsequently, it has been decided that ice should be manufactured in each island; and in order to keep operational costs to a minimum, ice will be made by a machine using a solar power system.

Since the frequency of the transport boat's arrival to the islands is limited, ice can be made gradually over a lengthy period of time which allows the process to be economically viable. A compact low maintenance chest freezer will be used for making ice. Fish will be packed with ice in well-insulated boxes. Generally from quality control viewpoint, guts, gills and blood should be removed, but guts of some fish such as surgeon fish or rabbit fish which are eaten, are not removed. One kilogram of ice will be needed for one kilogram of fish in order to keep the fish body temperature at 30°C. The ice making process is given in Appendix 2 and Figure 2-2..

7) Operation Costs

The monthly operation cost for transport and sale of fish products to Ebeye from the islands are roughly estimated as shown below.

Unit: US$

	Ship Transport	
	Once a Month	Twice a Month
Fuel Cost of Boat	675	1,350
Maintenance Cost	300	300
Personnel Cost		
Captain	350 (10 days)	700 (20 days)
Engineer	300 (10 days)	600 (20 days)
Personnel in outer islands	300 (5 days x 3 persons)	600 (10 days x 3 persons)
Personnel in Ebeye	250 (10 days)	500 (20 days)
Maintenance costs of other equipment	100	100
Total	2,275	4,150

Note: Fuel cost includes the annual visit to Majuro. Maintenance cost of other equipment includes the once a year inspection and repair costs for each island and the cost of the generator operated 2.4 hours per day. (2 liters per hour x 2.4 hours x 10 days = 48 liters) is estimated.

8) Sales Price of Fish

The current retail price of fresh fish on Ebeye, irrespective of species, is US$3.30 per kg ($1.50/lbs) and the wholesale price is US$2.75 per kg ($1.25/lbs). If the person in charge of sales on Ebeye were to obtain direct contracts with the retailers, the sales price of fish for this Project can be planned at equivalent to the current wholesale price to the retailers. In this case, however it may be difficult for newcomers to begin operations in terms of distribution of fish, transport, collecting cash, etc. Therefore, it is recommended that commissions be paid to wholesalers who currently have a network of retailers. The

commissions would be approximately 10 percent of the wholesale price considering the small handling volume. Consequently, the sales price of fish products minus the commission to the wholesaler would be US $2.47/kg ($1.12/lbs). However, this price is based on the current price of fish. If the volume of fish supply increases, there is the risk that prices of some fish species may drop.

9) Producers' Price

Dried and salted fish has been transported by air and sold in limited quantities by each island. The retail price of fish in this case has been US $1.00 per fish, minimum weight 450 g per fish (one pound). The cost of air freight from each island to Kwajalein is US$0.77 per kg (0.36/lbs). Therefore, the producers' price is US$1.43 per kg ($0.64/lbs). This is equivalent to a raw fish of US$0.84 per kg (0.38/lbs); and it is recommended that the producer's price for this Project should be planned to be higher than this.

Per capita income per day from copra is at most US$10 and if the producer's price for this Project is planned at US$1.00 per kg ($0.45/lbs), 10 kg of harvested fish would be equivalent to the earnings made from copra.

If the engine of the demonstration fishing boat which will be provided by this Project is a 40 horsepower diesel type, one fishing trip to fishing grounds one hour away would consume about 20 liters of fuel. Therefore the cost of one round trip is estimated at US$5. The Project fishing boat will accommodate ten fishermen who will participate in group fishing using spear, gill-nets, drive-in nets, etc. Such fishing expeditions are expected to catch a minimum of 200 lbs per fisherman per trip and the fuel cost is US$0.06 per kg ($0.03/lbs) of fish caught. If the fishing boat is not used in trolling where only a few fishermen are needed and fuel costs are very high, it is possible to keep the percentage of production cost of the fish price quite low.

10) Financial Viability

The monthly financial viability of the Project when implemented according to the above is as follows:

Approximate Estimate of Monthly Revenue and Expenditures

Unit: US$

	Frequency of Transport		
	Once a Month	Twice a Month	Remarks
Operating costs	2,275	4,150	
Fuel cost	675	1,350	
Maintenance cost of boat	300	300	
Maintenance cost of other equipment	100	100	
Personnel expense	1,200	2,400	
Revenue	3,080	6,160	700 kg of fresh fish collected in each island at one time.
Sales of fresh fish	5,180	10,360	Unit price US$2.47/kg
Purchase from Fishermen	-2,100	-4,200	Purchase price US$1.00/kg
Balance	805	2,010	

The balance for the transport and sale of fresh fish will be in the black. However, if operating expenses increase due to a drop in fish price caused by an increase in fish supply or to a rise in the price of diesel oil, it is foreseen that Project operations will run at a deficit (see next table). In such cases, it is recommended to transport and sell dried and salted fish, breadfruit, coconut products, handicrafts in Ebeye, while transporting rice and other daily commodities on the boat's return trip in order to help overcome the deficit.

Sensitivity Analysis

Unit: US$

Increase in Operating Cost	Drop in Fish Retail Price					
	Once a Month			Twice a Month		
	0%	-10%	-20%	0%	-10%	-20%
0%	805	203	-231	2,010	974	-62
10%	575	-27	-461	1,580	544	-492
20%	345	-255	-691	1,150	114	-922

3.2.2 Feasibility of Management

(1) Securing the Required Personnel

The following personnel will be required to manage the Project:

a) Three personnel in charge of operations on the islands: Each person will be responsible for supervising the fishermen, will oversee collection and shipment of fish, and will maintain facilities on one atoll.

b) One personnel in charge of sales in Ebeye: This person will be responsible for selling the fish products brought in from the islands.

c) Two personnel in charge of operating the transport boat: The captain and an engineer for the transport boat which will transport fish products from the outer islands to Ebeye will be required.

d) One personnel to supervise the Project: A supervisor who will be responsible for total management of the Project will be required.

It will be necessary to employ personnel who will be capable of supervising the fishermen at each island, and of collecting the required volume of fish products for transport to Ebeye. Several promising candidates who are presently inhabitants of or who are originally from the islands are being considered. During the interview survey conducted at each island, there were several people who appeared promising as candidates for such a post. Subsequently, it was concluded that there would be no problem in filling such a post with capable personnel.

Simultaneously, candidates for overseeing fish sales in Ebeye were also being reviewed. However, the details are not known. If appropriate personnel cannot be found, another possibility would be to appoint a wholesaler in Ebeye to carry out the work.

There are many experienced personnel in MIMRA and the private sector who are under consideration for the post of captain of the transport boat. In addition, there are many experienced boat engineers in the private sector. The Project supervisor will be assigned from the project management unit which is planned for MIMRA.

As can be deduced from the above, the government of the Marshall Islands is acting aggressively to secure the required personnel; and there appears to be no particularly large problems to overcome in acquiring the required personnel. However, in order for the Project to succeed, the capability of each person involved in the operation of the Project is

an important. Therefore, it is necessary to thoroughly evaluate the capability, experience, and personality of the candidates during the selection process.

(2) Budget for the Operation of the Project

In order to purchase fish from the fishermen on each island, approximately US$ 5,000 will be allocated as initial operational funds to pay for various costs incurred during the initial stages of the operation. This amount is equivalent to the total costs incurred for fish purchased from fishermen, operating costs of the transport boat, and personnel costs for approximately two months. In addition, as explained in Section 3.2.1 of this report, since there may be a monthly deficit of US$ 1,000 when fish price drops to 20 percent and operating costs increase to 20 percent according to a sensitivity analysis of the Project's income and expenditures, it is necessary to prepare about US$12,000 in supplementary funds to cover the deficit.

The past operating budgets of MIMRA are as follows:

Fiscal year 1988 US $288,300
Fiscal year 1989 US $367,900
Fiscal year 1990 US $371,400

An estimated budget of US$467,167 will be allocated for the fiscal year of 1991. A special budget for this Project is to be allocated in 1992 when the operation begins based on the results of the basic design survey. Based on MIMRA budgets in the past, the operating budget for the Project is not anticipated to be a financial burden; and it has been concluded that MIMRA is fully capable of providing operating funds and supplementary funds to cover the deficits after the commencement of the operation.

3.2.3 Relation to Other Similar Projects

The Project For Local Fishery Development in the Marshall Islands in the Arno atoll was implemented under Japanese grant aid; and fish landing facilities, refrigeration facilities, etc. were completed in Arno and Ine in 1991. Operation of these facilities in Arno has commenced; and in Ine, operations will begin in May 1991. This is a pilot project for local fishery development program and involves transporting and selling fish products from the Arno atoll to the capital, Majuro. This project was started in 1989 with the assistance of the Overseas Fisheries Cooperation Foundation (OFCF) prior to completion of the facilities, and has steadily borne fruit.

The aim of this Project is to expand the aforementioned pilot project to the outer

islands near Ebeye, where the second largest population of the nation is concentrated. It is the nucleus of the coastal fisheries development plan under the Second Five Year Plan.

On the other hand, in Ebeye there is a plan to introduce a pilot fisheries project exporting fish based on a survey carried out by the Asian Development Bank. Long line fishing to catch large migratory fish species such as bonito and tuna and small scale purse seiners to catch bait fish for long line fishing will be introduced. Distribution and processing facilities will be set up in Ebeye; and frozen and fresh tuna for sashimi, and frozen tuna for canning will be exported.

Both the aforementioned project and this Project may overlap in supplying fish for local consumption in Ebeye. In discussions between the survey team of this Project and the ADB appraisal mission during the field survey, it was clarified that the ADB project would be mainly concerned with the export of tuna, and would not overlap with this Project which would mainly be concerned with harvesting and supplying reef fish. In addition, it was agreed that the ADB project will give priority to generating foreign currency through fish export while this Project will concentrate on supplying fish from the outer islands for domestic consumption. Although details as to the volume of fish which will be supplied for domestic consumption through the ADB project were not mentioned, even if 10 percent of the production volume were to be earmarked for domestic consumption, it would only supply 30 percent of the potential demand in Ebeye combined with the volume of fish which will be supplied by this Project. Subsequently, it was concluded that there would still be sufficient demand to justify this Project.

3.2.4 Study on the Requested Facilities and Equipment

A study on the requested facilities and equipment is given below. However, concrete details on scale, specifications, etc. are discussed in Chapter 4 of this report.

1) Landing Facilities

Landing facilities will be built at each island to enable easy loading and unloading of fish products, diesel oil, fish boxes, and other needed goods for the transport boat. These facilities will be a nucleus for collection and shipping of fish products.

The three islands do not have any landing facilities as yet. Loading and unloading of goods from the inter-atoll transport vessel which comes around once every three months is done by canoe or small motorboats with outboard engines. Loading and unloading of goods using such unstable small boats is quite dangerous; and it is not uncommon for bags

of copra, which is the main commodity shipped out from the island, to fall into the sea. The transport boat which will be provided by the Project will not have a direct access way; and therefore, it will be necessary to build landing facilities to enable easy loading and unloading of goods. Moreover, since these fish landing facilities will function as a fish landing base for the atoll, it is anticipated that it will greatly promote the fishing industry on the island.

There are several types of landing facilities such as gravity type, piled jetty, floating jetty, etc. and it will be necessary to select the type suitable to the sea conditions and topography at each Project site. A discussion on the structure, design, etc. of the landing facilities at each site is given in detail in Chapter 4, "Basic Design".

2) Transport Boat

Fish products from the islands to Ebeye is currently transported by the inter-atoll transport vessel (Microship) or by air freight. The Microship makes its rounds to the islands once every three months, stopping at other islands on the way, which makes it unsuitable as a means of transporting fresh fish. Air freight from the islands to Ebeye is US$0.77 per kg and expensive in comparison to ocean freight; and the transport volume by air is limited. Therefore, air freight was ruled out as a major means of transport for promotion of the fishery on the outer islands. Subsequently, the introduction of a transport boat is vital. However, operational costs must be kept to a minimum to make the project commercially viable. As delineated in section 3.2.1 (2) of this report, the operation will be commercially viable if the transport boat is 15 meters long. In addition, as delineated in section 3.2.2, personnel required to operate, maintain, and control the transport vessel can be procured without any major difficulties. Details on specifications have been given in Chapter 4, "Basic Design", of this report.

3) Cold Storage

As the preference for fresh fish is very strong throughout the entire nation, it is essential that fish products transported from the outer islands are mainly fresh fish. However, the distance from the islands to the consumption area is great in comparison to the Arno project; and in order to keep running costs to a minimum while keeping fish freshness, fish products should be preserved in ice rather than directly refrigerated. As delineated in section 3.2.1(2), procurement of ice at Ebeye is difficult and it is necessary to make ice on each outer island. To economize on operation costs, an appropriate measure would be to install a small freezer which runs on a solar power system to make the ice. Solar power systems have been in use for ten years in the Marshall Islands in such areas as Utirik; and they have been trouble free and used successfully for long periods of time.

Fish products will be packed with ice produced by this freezer in insulated boxes. Consequently, insulated boxes will be required in addition to the freezer. A small building should be planned to house the freezer, office for the purchase and shipment of fish, and a storage for equipment.

4) Fishing Boat (For Demonstration)

This fishing boat will be used to secure a planned volume of fish for collection at the islands. The boat will be utilized in joint fishing operations of about ten people using stable, low-cost fishing methods such as spears, gill-nets, and drive-in net and will be used to teach fishermen fishing techniques and methods of fish handling.

Intrinsically, fish which will be transported from the islands should be caught by local fishermen using canoes or outboard motorboats. However, priority will be given to establishing a marketing system which will handle good quality fresh fish in the required volume. Therefore, it was concluded that fishing boats which are capable of harvesting a stable supply of fish under the direct supervision of the person in charge of fish collecting on the islands, would be needed. As evaluated in section 2.3.5, the most stable fishing methods are spear fishing, gill-net fishing, and drive-in fishing, with operational costs much lower than trolling and hand line. As a ten passenger capacity diesel fishing boat is sufficient to contribute for up-grading fishing techniques and fish handling, it is appropriate to provide the boat for demonstration.

5) Fishing Gear

Fishing equipment which will be used with the aforementioned fishing boat is spears, gill-nets, and drive-in nets. Fishing gear owned by the fishermen is not sufficient to catch the volume of fish required at the beginning of Project operations. Therefore, it will be necessary to provide the fishing gear which will be utilized on planned fishing boat. The gear is compatible with fishing methods currently in use.

6) Equipment for Fishing Village

In order to facilitate overland transport of fish, repair equipment for machinery, equipment to repair the road in the fishing villages, trailer, etc. have been requested. Such equipment will support the Project by helping to promote the fishery in the outer islands and will enable fish collection, etc. to be carried out more easily. The equipment which is easy to maintain and cost-effective is to be provided.

3.2.5 Technical Cooperation

The objective of the Project is to transport and sell fish products from the outer island to Ebeye and thereby, enable the island to generate cash income. In order for this distribution system to become commercially viable, the following conditions must be met.

a) Secure planned volumes of fish in time for shipping schedules.
b) Maintain sufficient degree of freshness of fish.
c) Establish sales route in Ebeye and sell fish at a suitable price.
d) Smooth the marketing and transport system according to planned schedules by close communication among personnels on the above activities.

The manner in which the operations are carried out, either poorly or efficiently, will greatly influence the success of this Project.

Therefore, in order to implement the Project most effectively, it is necessary to train Project personnel and to receive supervision from specialists in fish marketing sent from a country with advanced fisheries.

3.2.6 Basic Policy on Cooperation Implementation

It is concluded that implementation of the Project under Japanese grant aid is appropriate in terms of Project effectiveness, feasibility, and management ability of the executive agency of Marshall Islands. Therefore, based on the premise that the Project will be carried out under Japanese grant aid, the contents of the Project was studied and the basic design was done in the following section of this report. Appropriate changes in the facilities are explained in the section 3.2.4 "Study on the Required Facilities and Equipment".

3.3 Outline of the Project

3.3.1 Executing Agency and Management Organization

After the Project has been completed, the management and operations of each facility, the transport boat, etc. will be handled by MIMRA. Management and operations is a vital factor in the success of this Project and it is necessary to thoroughly review the capabilities of the personnel and to outline their sphere of responsibility when establishing the management organization of the Project. Required management personnel of the Project are given below.

1) Personnel In Charge of Fish Collection on the Outer Island

One person in charge of fish collection, weighing-in, shipment, and operation of the facilities will be placed at each of the three atolls. It is desirable that the person in charge of these duties is representative of the fishermen, is familiar with the conditions on each respective atoll, and will be able to contribute to improving the local community. Therefore, such personnel should not only be selected from MIMRA, but should also have originated from the island. The role of this personnel is outlined as follows:

a) The person-in-charge will be required to keep in close contact with the fishermen in order to collect the required volume of fish in time for shipping schedules, while keeping in contact with the transport boat and Ebeye. In addition, he must utilize the demonstration boat and take the initiative in supervising the fishermen, and see to it that the required volume of fish products are collected. He must weigh-in the collected fish, and keep a record of fish species, and size delivered by fishermen.

b) He is responsible for packing the collected fish products with ice made according to the schedule shown in the Appendix 2, Fig. 2-2.

c) He must be thoroughly knowledgeable about consumer demands on Ebeye, and must be capable of supervising the fishermen in harvesting fish species according to the demand, in addition to overseeing fish quality control.

d) He must maintain the freezer, the fish landing facilities as well as the fishing boat, and is responsible for minimizing operational costs and breakdowns. In particular, private use of the freezer and the fishing boat must be avoided at all cost and daily inspection and maintenance must be carried out.

e) He is responsible for informing MIMRA immediately of breakdowns and for requesting repairs.

2) Personnel In Charge of Sales on Ebeye

One person will be assigned to handle fish sales to the supermarket and grocery stores on Ebeye. This person must be knowledgeable about the conditions on Ebeye and must be able to establish trust between himself and the local retailers. The duties of this position are as follows:

a) He must secure sales contracts with the supermarket and the grocery stores and if necessary, he must obtain the cooperation of the wholesalers to secure a sales route for fish.

b) He will be required to keep in contact with the personnel in charge of fish collection on the outer islands, make preparations for receiving the consignment of fish, contact the retailers, distribute the fish upon its arrival, and record fish species according to size, weight, price, and destination.

c) After the sale has been completed, he will be responsible for collecting the money and sending it to the personnel in charge of each outer island.

3) Operator of the Transport Boat

A captain and one engineer will be employed to operate the transport boat. There are large ocean swells between the islands and the captain must be familiar and thoroughly experienced in navigating through these waters. In addition, the engineer must be experienced in inspecting and repairing diesel engines and fully capable to maintain equipment and machinery belonging to a boat of this class. At the initiation stage of Project operations, the transport boat will make one round trip per month to each island from Ebeye for a total of three round trips per month. However, in future it is anticipated that the boat will make two round trips per month to each island for a total of six round trips per month. It may be necessary that trips will be made on a rotational basis between two set of crews.

4) Project Manager

One personnel from MIMRA will be placed in charge of overseeing the entire management of the Project. A project management unit within MIMRA will be established under the Second Five Year Plan; and the Project manager will be placed in this unit.

His duties will be to keep in contact with the aforementioned personnel, to check operational and financial conditions of the Project, to provide the required instructions, while supplying required materials, funds, etc., and distributing them in a timely fashion.

3.3.2 Operational Plan

The objective of the Project is to transport and supply fish products to Ebeye, a consumption area, from the three closest outer islands. The Project will enable the islands' inhabitants to earn cash income while simultaneously solving Ebeye's fish shortage.

(1) Method of Transporting Fresh Fish

The demand for fresh fish in Ebeye, in terms of potential fish harvest volume at each island is small about 700 kg (1,500 lbs) for one trip. In addition, the distance between Ebeye and the outer islands is relatively far at 70 to 200 km. An important objective of the Project is to maintain low transport costs in order to keep the Project financially viable. Subsequently, only one transport boat will be utilized to transport fish products between Ebeye and the outer islands. The engine power and the number of crew members will likewise be kept to a minimum. The transport boat will collect fish products from only one island per trip. In order for the transport boat to visit all three islands once will require 14 days as shown in the table below. Hence, the maximum number of times the transport boat will be able to collect fish from each island is twice a month. However, setting up a marketing system is the first priority. Therefore, fish will be transported only once a month from each island during the initial stages of the Project.

Number of Navigational Days of Transport Boat

	Departure	Island	Return	Ebeye	Total
Ebeye - Likiep	1 day	1 day	1 day	2 days	5 days
Ebeye - Namu	1 day	- -	1 day	2 days	4 days
Ebeye - Ailinglaplap	1 day	1 day	1 day	2 days	5 days
Total	3 days	2 days	3 days	6 days	14 days

Note: The days at Ebeye also include rest and refueling.

(2) Fishing and Fish Quality Control on the Outer Islands

The single greatest project operating cost will be transportation. Therefore, it is essential that costs incurred for making ice or fishing on the outer islands are kept as low as possible. In order to achieve this, the following measures will be implemented.

1) Fishing Methods

Currently utilized fishing methods such as spear fishing, drive-in nets, gill nets, etc. will be given priority and methods such as trolling, etc. which require the use of moving boats will be secondary. The Project fishing boat will work the fishing grounds scattered on the lagoon side and will carry approximately ten (10) fishermen who will be responsible for catching the fish.

Two-thirds of the estimated 700 kg of fish catch, i.e. 450 kg (about 1,000 lbs), will be caught by spear fishing which is anticipated to be the most reliable method of fishing. The remaining one-third of the catch or about 250 kg (500 lbs) will be caught by other fishing methods. Fish will be harvested two days prior to the scheduled arrival of the transport boat and the catch will be divided into 50 kg lots and packed into the insulated boxes with ice. Since the total volume of fish products is minimal and handling is limited once or twice a month, one person will be able to handle this operation on each island.

2) Plan on Fish Quality Control

Ice will be produced on each island, as the ice manufacturing capability on Ebeye Island is unable to cope with its own demand for ice. Electrical power required to manufacture ice must be supplied by either a solar power or a generator since there are no power plant on these islands. The Project will not utilize the common generator with its high operational costs, but will depend on a solar power system which is cost-effective after the initial investment. In this way the operational expense for ice manufacturing can be reduced. In order to preserve fish freshness, a volume of ice will be manufactured equal to the planned fish catch (700 kg/shipment/island).

As the transport boat will be able to collect the fish only once every two weeks, ice will be manufactured in small amounts for a period of about ten (10) days, as shown in the ice making schedule in Appendix 2, Fig. 2-2, and will then be transferred to the insulated boxes, in readiness for the fish.

Although it is desirable for the fish to be refrigerated as soon as it is caught for quality control, it has been decided that fishermen will be supervised and trained to return with their fish catch as soon as it has been landed. This approach has been taken since it will be difficult and costly to load ice into the canoes which have limited space, and also since fishing grounds are all within an hour's travel.

The fish catch, after removal of guts, gills and blood (except those fishes such as surgeon fish or rabbit fish whose guts are eaten) and washing in fresh water or sea water, will be packed immediately into the insulated boxes with an equal amount of ice. The fish will be pre-cooled in the melted ice water in the insulated boxes to maximize the effects of icing. If this is not done, it will take longer for the internal body temperature of the fish to drop to $0^{\circ}C$ when it is iced; and there will be a drop in fish quality. It is vital that fish products are preserved in temperatures of at least $0^{\circ}C$ in order to maintain optimum quality. Other effective measures include adding three to four percent salt to the ice water and maintaining temperatures at $2^{\circ}C$.

The fish packed in ice in the insulated boxes will be loaded onto the transport boat and freighted to Ebeye Island where they will be transferred into the store refrigerators or insulated boxes. The empty insulated boxes will then be carried to the next island where they will be exchanged for insulated boxes containing fish.

(3) Fish Sales on Ebeye Island

At the initial stage of the Project, fish products will be shipped to Ebeye Island once a month from each island for a total of three shipments a month at 700 kg per one shipment. The fish will be distributed to grocery stores according to their sales capacity. It is desirable for a sales contract to be made with at least one supermarket and ten grocery stores.

The volume of fish to be distributed will be limited to approximately 250 kg for the supermarkets and under 50 kg for each grocery store. In principle, transporting the fish to each grocery store will be the responsibility of the grocery store itself. Therefore, it is essential that the date and time of fish arrival, fish volume, species, etc. is passed to the retailers. The need to obtain the cooperation of the wholesalers should also be considered. In addition, it is important to have data on consumer demand and to be in constant contact with the fishermen on the outer islands, in order to avoid having fish go unsold.

3.3.3 Location and Condition of Project Site

(1) Likiep

The Project site, as shown in the map in the beginning of the report, is located on the lagoon side in the northeastern part of Likiep Island which is east southeast in Likiep atoll. The sea on the lagoon side of the Project site from east northeast to south southwest is protected by the land from trade winds; and is therefore calm.

Landing/loading site of inter-atoll vessel is near the Project site. The air field is located on the ocean side of the Project site. The distance to the air field from the site is approximately 500 meters. Houses are clustered within a few hundred meters of the site facing the main road. The lagoon in front of the planned landing facility inclines steeply below datum line. Inclination of the slope is estimated at about a 40 degree angle down to the water depth of 8 meters.

(2) Namu

The Project site is located in the central part of Majikin Island on the lagoon side in the northeastern part of Namu atoll. The site borders the land on the northeastern side and the sea on the southeastern side. When the trade winds blow in from an east northeasterly direction, the sea on the front side of the site is calm. However, when the winds blow from the opposite direction, the Project site will be affected by the wind and waves from the lagoon.

It is located in the central part of the island where homes are concentrated and is adjacent to the main road on the island. Landing/loading site for inter-atoll vessel is near the Project site. The air field is located north-west ocean side of the site, and the distance from the site is approximately 700 meters. The proposed site for the landing facilities is located in a relatively shallow sandy shore and the water depth is 2 meters, 70 meters offshore (during maximum high tide).

(3) Ailinglaplap

The Project site is located in the northwestern part of Bouj district in Airok Island which is in the southern part on Ailinglaplap. The site borders a channel which connects the ocean and the lagoon, and is rarely affected by the trade. However, when there are opposing winds from the southwest, the site may be affected by the wind and waves.

Landing/unloading site for inter-atoll vessel is near the Project site. The air field is located east end of the island, and the distance from the site is approximately 9 km. On the east side of the island in the Airok district, there are approximately 370 people or 48 percent of the population. In central Jabuwan district, there are 117 inhabitants or 15 percent of the population; and in Bouj district where the Project site is located, there are 285 inhabitants or 37 percent of the population. All three districts are connected by the main road and the Project site is located at the western end of this road.

3.3.4 Outline of Facilities and Equipment

An outline of the facilities and equipment selected as appropriate for the Project based on the examination of the contents of the request is given below.

Facility/Equipment	Content/Scope	Quantity
Landing Facilities	Gravity type jetty, piled jetty, floating jetty, barge, etc. will be selected according to the natural conditions of each site.	1 set for each island
Transport Boat	Length about 15 m, 100 hp diesel engine	1 boat
On-land Facilities	Small freezer operating on solar power (for making ice), office, includes storage for equipment.	1 set for each island
Fishing Boat (For demonstration)	Accommodates 10 fishermen, diesel engine type	1 boat for each island
Fishing Gear	Fishing equipment currently in use such as spears, gill nets, drive-in nets, etc.	1 set for each island
Equipment for Fishing Village	Equipment such as trailer to support land transport of fish products, road repair, repair tools that are easy to maintain will be selected	1 set for each island

Note: Details on facility/equipment specifications, quantity, etc. will be given in "Chapter 4 Basic Design".

3.3.5 Maintenance and Control Plan

MIMRA will be responsible for much of the maintenance and control of equipment and facilities. Relevant Project personnel such as the manager in charge of fish collection on each island, the captain and engineer of the transport boat, etc. will carry out inspection, maintenance, and daily management of each facility and equipment under the supervision of MIMRA. However, for repairs which require specialized or skilled knowledge beyond the capabilities of Project personnel, MIMRA will be responsible for dispatching the required technicians.

(1) Operation and Maintenance Plan

Maintenance of major facilities and equipment are as follows:

1) Transport Boat and Fishing Boat

- Replacing engine oil — Once every 250 hours of operation
- Replacing oil filter — Same as above
- Replacing fuel filter — Once every 1000 hours of operation
- Replacing gear oil — Once every 5000 hours of operation
- Periodic inspection
  Engine overhaul
  Piston ring replacement
  Nozzle replacement
  Washing the boat's bottom, painting, etc.

2) Solar Power System

- Cleaning solar panels	Once a month
- Adding distilled water	Once a year (however, inspection of water level to be carried out twice a year)
- Replacing batteries	Once every 7 years

(2) Maintenance Costs and Financial Analysis

Projected financial statement including maintenance costs delineated above for the first ten years after commencement of Project operations, is shown in Appendix 4. The Project is anticipated to produce an annual profit of US$2,000 to $7,000 from the second year of Project operations. However, it will be necessary to supplement US$3,000 from saved profits to cover the cost of replacing the batteries at the seventh year of operation.

Moreover, if the retail price of fishery products was to drop or if operating expenditures were to increase, there is the possibility that earnings and expenses may fall into a deficit. Therefore, it is necessary to budget funds to cover any possible deficit and to budget for the replacement of the batteries.

4. BASIC DESIGN

4. BASIC DESIGN

4.1 Design Policy

4.1.1 Basic Design Policy

(1) Policy on Natural Conditions

1) Landing facilities will be designed to be convenient and durable, taking into consideration such factors as soil conditions, topography, wave conditions, etc. at each Project site. The facilities will be planned in a way that will minimize their effects on the water currents in case the facilities could adversely effect drift sand and erosion, even at the expense of convenience and durability. In particular, no action is planned that could aggravate erosion on the lagoon side of Majikin Island of Namu atoll. At this side there is also a moderate current flowing constantly at about 0.1 to 0.2 knots parallel to the shoreline at the site. Therefore, off-shore facilities here should be carefully planned since slight changes in topography and ocean current can lead to large topographical transformations.

2) In addition, landing facilities will be planned to minimize the effects on the ecological system of corals.

3) The ocean swells between the islands create waves five to six meters in height. Therefore, a transport boat which is very stable and seaworthy will be selected.

4) The introduction of an economical, cost-effective solar power system for freezer is planned utilizing strong sunshine in tropical zone.

5) Building well-ventilated structures are planned due to the high humidity characteristic of tropical oceanic climates.

6) Although the area is rarely hit by typhoons, based on past records, the structures will be designed to withstand maximum winds of 30 m/sec.

7) The structures will harmonize with the surrounding landscape.

(2) Policy on Social Conditions

1) Project sites were selected in the center of villages for convenience and their advantage in enabling the facility to blend into the daily life of the village people.

2) Each island has a church and school and both facilities are also utilized for community gatherings, etc. Therefore, the Project facilities will not include a community hall.

3) The Marshall Islands have been influenced by several foreign cultures which are reflected in the architectural styles of its buildings and structures. The structures to be built by the Project will be made of wood which is easy to repair and familiar to the people of the villages.

(3) Policy on Construction

1) Construction of Project facilities will be carried out in accordance with the regulations on construction works stipulated by the Environmental Protection Agency. Measures will be taken into consideration to protect the environment. The regulation on earthmoving is attached in Appendix 7.

2) Experienced workers and construction machines/materials are not available on the islands and therefore, they will be supplied from Majuro.

3) Since construction machines are limited in Majuro, the requirement for machines will be minimized. In addition, in order to efficiently carry out the construction work, landing and on-land facilities will be of prefabricated constructions.

(4) Policy on Utilizing Local Materials and Machines

Although the Project will follow a policy of utilizing local materials and machines, construction materials with the exception of sand and gravel made from coral rock, will be imported. Materials which are not commonly used locally will be difficult to maintain and manage. Therefore, priority will be given to materials which are widely used.

(5) *Policy on the Executing Agency's Management Capabilities*

In order to keep operating costs to a minimum, the transport boat and fishing boats will operate on diesel oil and the freezer will operate on a solar power system. Solar power systems have been in use for a long period of time throughout the nation; and it has been concluded that there will be no major problems in operation and maintenance of such systems. Among the fishing gear used by the local fishermen, equipment which will ensure a stable fish catch with low operating costs will be selected.

Other equipment will also be selected on the criteria of low operating costs and easy maintenance and operation by the local people.

4.1.2 Policy on Design of Facility and Equipment

(1) Landing Facilities

Soil conditions, topography, wave conditions, etc. were taken into consideration in designing landing facilities; and the facilities will be designed to have high convenience and durability. However, in sites where the possibility of erosion or sand drift may occur, emphasis will be placed on minimizing the effects on the water current rather than on convenience or durability.

(2) On-Land Facilities

A cost-effective solar power system to operate refrigeration facilities, etc. was selected. The structure which will house the office and the freezer will have the minimum required functions. The building structure will be a standard prefabricated type due to difficulties in carrying out construction work on geographically isolated islands. In addition, the design, structure, and specifications of the facilities planned will be easy to manage and maintain locally and will be able to withstand natural conditions such as the tropical climate, soil conditions, etc.

(3) Transport Boat and Other Equipment

In addition to being highly stable and seaworthy, the transport boat ship will be selected on its capacity to keep fuel costs to a minimum with sufficient horsepower to maintain the speed necessary to travel between the islands. The fishing boat selected will be diesel powered and its equipment will be cost-effective and easy to maintain.

4.1.3 Policy on Construction Period

Landing and on-land facilities will be a standard prefabricated structures which will require only a short implementation period for construction work due to the limited number of architects and construction equipment, the necessity of transporting equipment to the islands, and the limited number of landing craft needed for ocean transport of construction equipment and supplies. Hence, an effective implementation plan will be devised.

4.2 Study and Examination on Design Criteria

4.2.1 Study on Design Criteria

(1) Landing Facilities

1) Design on Wave Height

Throughout the survey period, the height of the waves were approximately 50 cm; and high waves were not visually observed in the sea which faces each Project site. Changes in wave height in the shallow ocean waters were based on significant wave heights estimated from visual observations of offshore waves. Average maximum wind velocities in Majuro were taken into consideration and the wave height of the seas facing the front of the Project sites were estimated.

	Likiep	Namu	Ailinglaplap
Average monthly maximum wind speed (m/sec.)	15	15	15
Wave height for design	1.1 (WNW)	1.0 (SW)	1.2 (SW)

Note: ( ) indicates wave direction.

2) Tide Levels

The tide levels at Namu and Ailinglaplap are based on a analysis of tidal harmonic constants using measurements taken with a tide gauge for approximately 15 days at each site. The differences in tide levels between Namu and Ailinglaplap were slight. However, the estimated value for tide levels in Namu were used in the case of Likiep since the Project site faces the side of the lagoon in a manner similar to that of the Namu Project site. The following table shows tide levels on the basis of the lowest low water.

Tide Levels	Likiep/Namu	Ailinglaplap
Highest high water level (H.H.W.L)	+1.84 m	+1.81 m
Mean high water spring (H.W.L)	+1.65 m	+1.65 m
Mean water level (M.W.L)	+0.92 m	+0.91 m
Mean low water spring (L.W.L)	+0.19 m	+0.16 m
Lowest low water level (L.L.W.L; datum line)	+/-0.00 m	+/-0.00 m

Note: The lowest low water level was used as the datum line.

3) Boats

Boats which will utilize the fish landing facilities are the transport boat, the fishing boat for demonstration purposes, and the local fishing boats with outboard motors (canoes will land their fish catch directly at the shore). There will be one transport boat and a maximum of 15 local fishing boats with outboard motors. Consequently, fish landing facilities should be large enough to accommodate the transport boat.

The following is the full length and its full load draft of transport boat (specifications will be given later):

	Full Length	Full Load Draft
Transport boat	15 m	1.5 m

4) Strength of Coral Rock

The strength of coral was estimated as follows based on the unconfined compression strength test.

Unconfined compression strength: 100-200 kgf/cm^2(10-20 MPa)

(2) On Land Facilities

1) Wind Speed

Based on climatological data in Majuro, instantaneous maximum wind speed for design was established as follows:

Wind Velocity: 30 m/sec

2) Soil Conditions

Soil conditions and soil durability were confirmed as follows:

Soil Conditions: coral sand and gravel
Soil bearing capacity: 5 tons/m^2

3) Concrete Strength

Concrete strength is based on standards generally used locally for major buildings:

210-240 kg/cm^2

4) Seismic Intensity

Seismic intensity was not considered for design since the Project sites are not located in the earthquake zone and there are no past records of earthquakes.

4.2.2 Basic structure and Scale of Facilities

(1) Landing Facilities

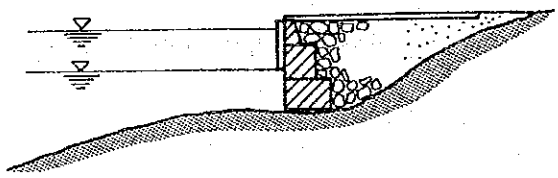
1) A Comparison of Basic Structural Plans

A comparative evaluation was made of the following three options of basic structural plans based on such factors as sea conditions, topography, soil conditions, etc. at each Project site. The option most appropriate to the project site will be selected.

Option A

Gravity type jetty

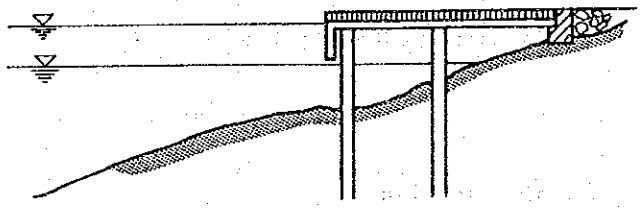
The construction of this type of jetty is suitable in relatively shallow water depth area with hard soil condition.



Option B

Pile jetty

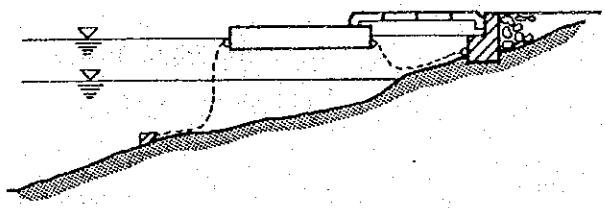
This type of jetty construction is suitable for soft soil areas, but is impractical in hard soil areas. The resistance to horizontal loading is not as good as Option A.



Option C

Floating jetty

This type of jetty is easy to install, however, the structure is easily affected by waves. Its effect on the environment in terms of sand drift is minimal.



a) Likiep

The sea bottom off the shoreline at the Project site in Likiep is a steeply inclined sand and gravel ground surface. In order for the gravity type jetty given in Option A to be constructed, it would be necessary to dredge to deep levels to prevent the jetty from slipping. Therefore, this type cannot be used.

In a comparison of Options B and C, Option C falls slightly short in terms of durability and convenience. In addition, in the offshore waters facing the site, the incline continues for approximately 20 meters. Therefore, in order to stabilize the pontoon, there is the added work of installing an anchor. Hence, Option B utilizing the piling method is considered most appropriate for jetty construction.

b) Namu

The northwestern area of the lagoon side of Majikin Island which is the Project site for Namu is eroding and there is a constant current flowing parallel to the shoreline on the front side of the Project site. Subsequently, Option A and B were not selected due to concerns about the effects of sand accumulation from sand drift and erosion on the environment. Although the method employed in Option C will have the least effect on sand drift, there is the possibility that major damage to the floating jetty may occur from wave conditions when there are opposing winds from the southwest. Hence, problems regarding durability arise. In addition, the front side of the Project site is rather shallow and in the case of a floating jetty, the distance from land to the pontoon will be more than 70 meters; and it will be difficult to install a connecting bridge without affecting the environment. Therefore, Proposals A, B, and C which will employ stationary methods for jetty installation are unfeasible for the Project site at Namu and a small barge will be used.

c) Ailinglaplap

The soil on the front side of the Project site at Ailinglaplap is composed of relatively hard coralline rock and gravel. The piling method in Option B is difficult to employ in terms of construction. In addition, a floating jetty as proposed in Option C is also unfeasible at this Project site since it faces a waterway which connects the ocean and the lagoon and is subject to currents by the ebb and flow of the tide and the ocean swells. However, Option A may be feasible if the jetty does not jut out on the sea side, and a gravity jetty is installed parallel to the beach line and the rock on the front side of the site is excavated; and thereby making it

possible to suppress the effects of the tide flow. Presently, there is an old trench with the depth of 30 to 50 centimeters on the front side of the site. The trench has no accumulations of sand. In addition, the surrounding areas have either rocky shore or a layer of gravel. Therefore, it was concluded that sand will almost never accumulate in an excavated channel. Hence, it was decided that Option A was suited overall for this Project site.

Evaluation of Each Structural Method

	Likiep			Namu			Ailinglaplap		
	A	B	C	A	B	C	A	B	C
Natural conditions									
Soil topography	X	O	P	X	O	P	O	X	P
Sea	O	O	P	O	O	X	O	P	X
Environment	X	P	O	X	X	O	P	P	O
Convenience									
Safety	O	O	P	O	O	P	O	O	P
Construction Conditions									
Construction personnel	P	P	O	P	P	O	P	P	O
Difficulty in construction	P	O	P	P	O	O	O	X	P
Overall Evaluation	X	O	P	X	X	X	O	X	X

Remarks: O; Most appropriate under the condition, P; Possible, but not better than O.
X; Should be avoided.

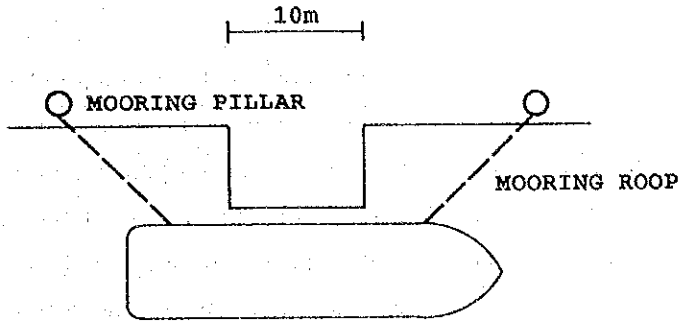
2) Scale of the Landing Facilities

a) Likiep

Length of quay wall should be one berth in order to allow the transport boat to moor. The total length of the transport boat is 15 meters. The following equation is used for the calculation of berth length including room of 15 percent of boat length.

$$\text{Berth Length} = 15\ \text{m} + 0.15 \times 15\ \text{m} = 17.25\ \text{m}$$

However, in Likiep as shown in the figure below, a mooring pillar can be placed on both ends of the mooring area to reduce the length of the quay to approximately 10 meters and still have safe and convenient loading and unloading.



The water depth at the quay wall will be -2.0 meters below the datum line which allows a surplus of 50 cm for a full load draft of 1.5 m of the transport boat at low tide. During low tide when there are waves higher than one meter, it will be necessary for the transport boat to wait out the tide. However, since the boat will arrive only twice a month, this is not expected to be a great impediment.

Based on the above, the mooring jetty will contain a quay wall about 10 meters in length and a mooring area -2.0 meters in water depth.

b) Namu

The small barge which will be provided at the Project site in Namu will be selected for its convenience in loading and unloading cargo and for its stability. It will be a FRP manufactured barge about 6 m x 3 m in size which can land itself. The capacity of one trip is about 1,600 kg of fish products, ice, and insulated boxes. In addition to this cargo, it will be required to carry other commodities and about five persons. Therefore, it must be 70 cm in depth to be able to carry a minimum load of two tons.

c) Ailinglaplap

In order to construct a quay wall parallel to the beach line, the front side of the Project site in Ailinglaplap must be excavated; and as in the case of the jetty in Likiep, mooring pillars must be installed. The quay wall will be about 10 meters in length.

The mooring area on the front side of the site will have a water depth of -2.0 meters similar to the site at Likiep. A water area twice the length of the transport boat and about 30 meters wide will be excavated to allow the transport boat to turn around. The width of the excavation near the exit will be the same length of the boat or 15 meters which is equivalent to minimum Japanese standards for harbors.

(2) On-Land Facilities

A refrigeration system operating on solar power will be a major characteristic of the on-land facilities which will also include radio-telephone, an office, storage, etc. which will be rationally laid out in a minimum space. In addition solar panels will be attached to the roof of the building. The floor space of each room is given in the table below. The on-land facilities at each island will have the same specifications and will be standardized to reduce the construction period and to enable easy maintenance and control of the facilities.

Room	Description	Scale
Fish Storage	The freezer will be on one side of the room (450 liters x 3); 15 insulated boxes will be placed on the other; work space to handle fish and ice will be placed in the center.	Approx. 18 m^2
Battery Room	A solar energy storage battery, distribution panel, and emergency generator will be installed; work space for inspection and repairs will be placed in the middle.	Approx. 12 m^2
Work Area	Work space for collection of fish products, weighing-in, shipping will be made; space for pushcarts and tractors to move about will be available.	Approx. 30 m^2
Office	Work space for organizing collection slips, accounting, etc. will be provided; shelves for fishing equipment parts, radio-telephone, etc. will be installed.	Approx. 19 m^2
Storage	Fishing equipment, spare parts will be stored.	Approx. 4 m^2
Fuel Depot	Drums containing diesel oil for demonstration fishing boat, gasoline for out-board motorboats, etc. will be stored.	Approx. 7 m^2
Water Tank	Water tanks will be of sufficient capacity to collect rainwater for general use and for the manufacture of ice during the dry season.	3 tons x 3 tanks
Toilet	According to local custom, the toilet will be housed in a separate area building. One toilet will be provided.	1 set

(3) Utilities

The number of solar panels for the solar power system and the storage battery capacity required for the facilities will be determined by the insolation and the load. According to climatological data on Majuro, the longest period of continuous cloud was three days. By using insolation estimated from the latitude, it was estimated that approximately 600 wh will be consumed by three freezers and room lights. The required

number of solar panels and the capacity of the storage battery was then determined according to this estimation.

A minimum of two inverters will be installed in order to avoid a power failure of the entire system when an inverter breaks down. Hence, wiring which will allow electricity to be supplied from two inverters will be provided. In addition, one emergency generator will be provided when there is a shortage of sunlight.

Utilities	Description	Quantity
Solar Power System	Solar panels	120 sheets
	Inverters	2 sets
	Control panel	1 set
	Battery 12V 200 AH	1 set
	Emergency 3.5 KVA	1 set
Freezer	Chest freezer (450 liter storage capacity; -20°C; electric power consumption 170 W).	3 sets
Communication	SSB radio-telephone, antenna to communicatee with transport boar, Ebeye and Majuro.	1 set
Lighting	Fluorescent lighting of 40 W will be provided for each room.	6 lights
Water Supply & Drainage	Sink in the work area and floor drainage	1 set
Sewer Treatment	Septic tank and filtration sump	1 set
Street Light	Street light within the compound on the side of the road; solar power 20 W.	1 set