

NO. 1

Office of Vice President  
Republic of Palau

**BASIC DESIGN STUDY REPORT  
ON  
THE PROJECT FOR ESTABLISHMENT  
OF  
THE PALAU INTERNATIONAL CORAL REEF CENTER  
IN  
THE REPUBLIC OF PALAU**

**DECEMBER 1998**

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SYSTEM SCIENCE CONSULTANTS INC.  
MARINE PARKS CENTER OF JAPAN**

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BASIC DESIGN STUDY REPORT ON THE PROJECT FOR ESTABLISHMENT OF THE PALAU INTERNATIONAL CORAL REEF CENTER IN THE REPUBLIC OF PALAU

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SYSTEM SCIENCE CONSULTANTS INC.  
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## PREFACE

In response to a request from the Government of the Republic of Palau, the Government of Japan decided to conduct a basic design study on the Project for Establishment of the Palau International Coral Reef Center and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Palau a study team from November 8 to November 27, 1997, from April 7 to May 1, 1998 and from July 5 to July 11, 1998.

The team held discussions with the officials concerned of the Government of Palau, 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 Palau in order to discuss a draft basic design, and as this result, the present report was finalized.

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

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

December, 1998



Kimio Fujita

President

Japan International Cooperation Agency





December, 1998

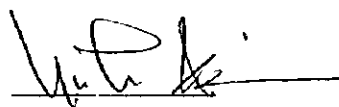
## LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Establishment of the Palau International Coral Reef Center in the Republic of Palau.

This study was conducted by the joint venture of System Science consultants Inc. and Marine Parks Center of Japan, under a contract to JICA, during the period from October 31, 1997 to December 24, 1998. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Palau and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,



Yasuhiko Taki

Project manager,

Basic design study team on

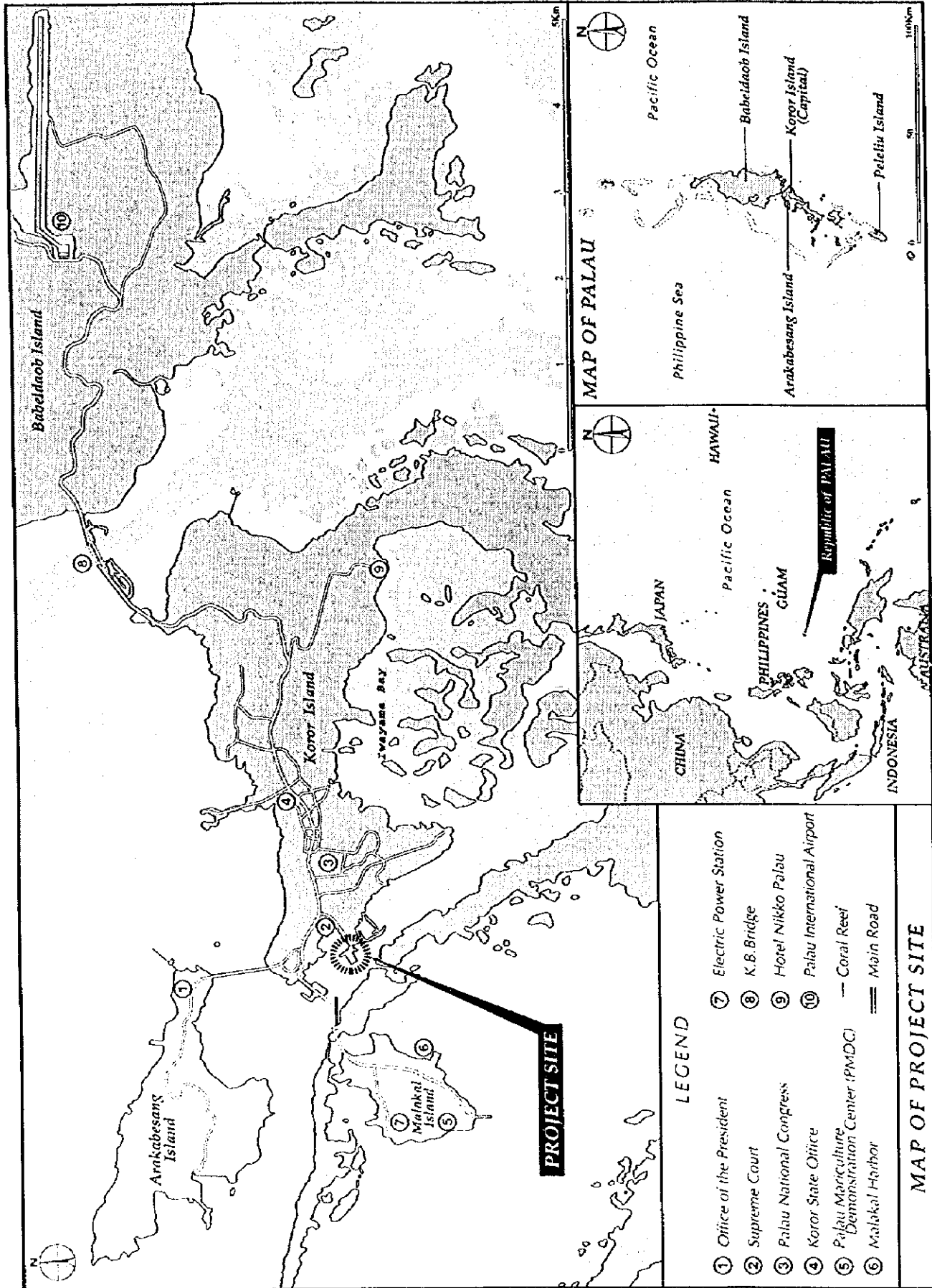
the Project for Establishment of

the Palau International Coral Reef Center

Joint venture of

System Science Consultants Inc. and

Marine Parks Center of Japan



Babeldaob Island

8

Arakabesang Island

1

Koror Island

4

3

2

Wayaama Bay

6

Malakal Island

7

5

**PROJECT SITE**

5km



MAP OF PALAU

Pacific Ocean

Philippine Sea

HAWAII

Pacific Ocean

JAPAN

PHILIPPINES

GUAM

Republic of PALAU

INDONESIA

AUSTRALIA

LEGEND

- ① Office of the President
- ② Supreme Court
- ③ Palau National Congress
- ④ Koror State Office
- ⑤ Palau Mariculture Demonstration Center (PMDC)
- ⑥ Malakal Harbor
- ⑦ Electric Power Station
- ⑧ K.B. Bridge
- ⑨ Hotel Nikko Palau
- ⑩ Palau International Airport
- Coral Reef
- == Main Road

MAP OF PROJECT SITE

100km



Project for Establishment of Palau International Cora. Reef Center

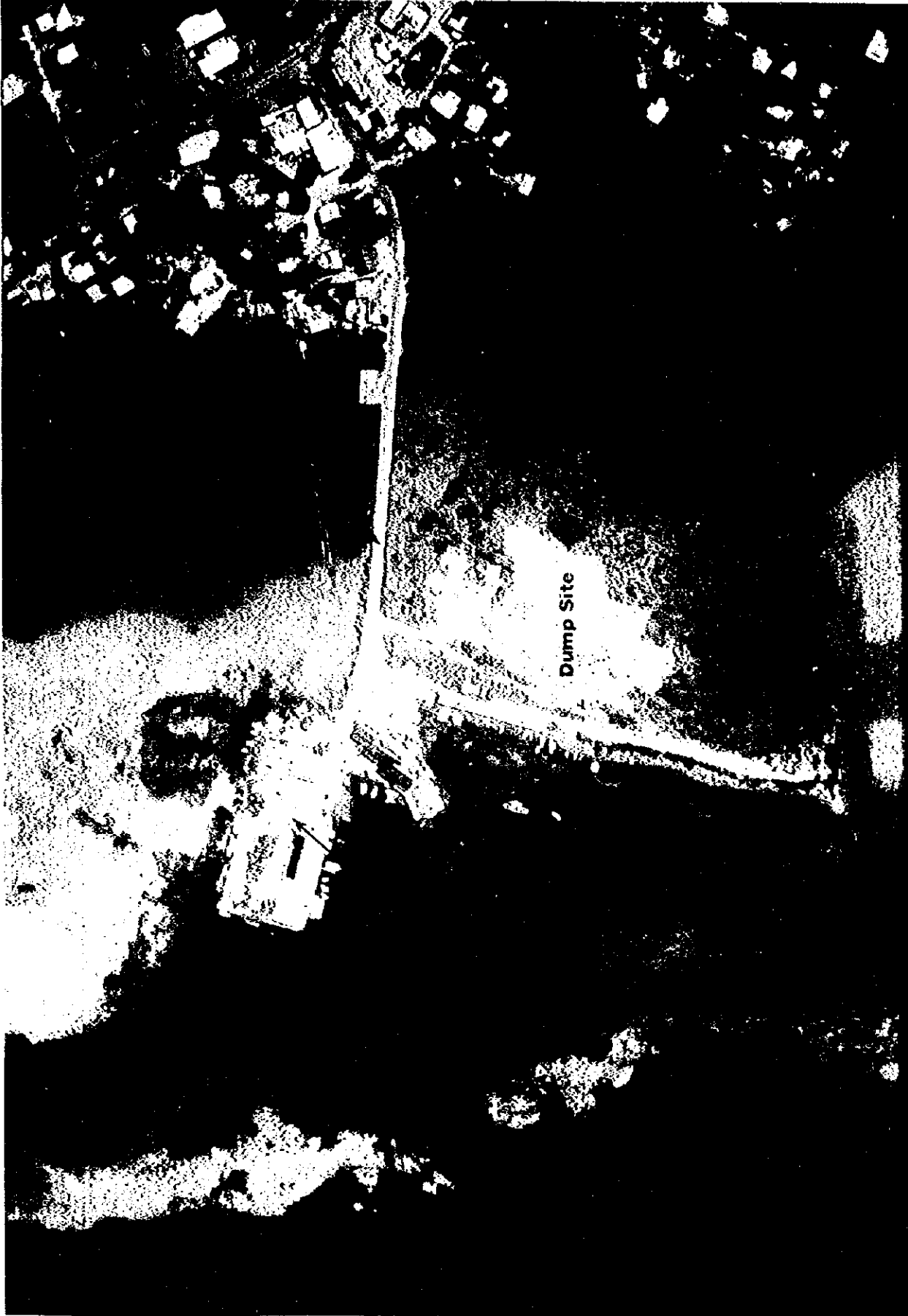
Perspective



■ **Aerial Photograph - 1** (A distance view showing the location of the Project site)



Aerial Photograph - 1 (A distance view showing the location of the Project site)



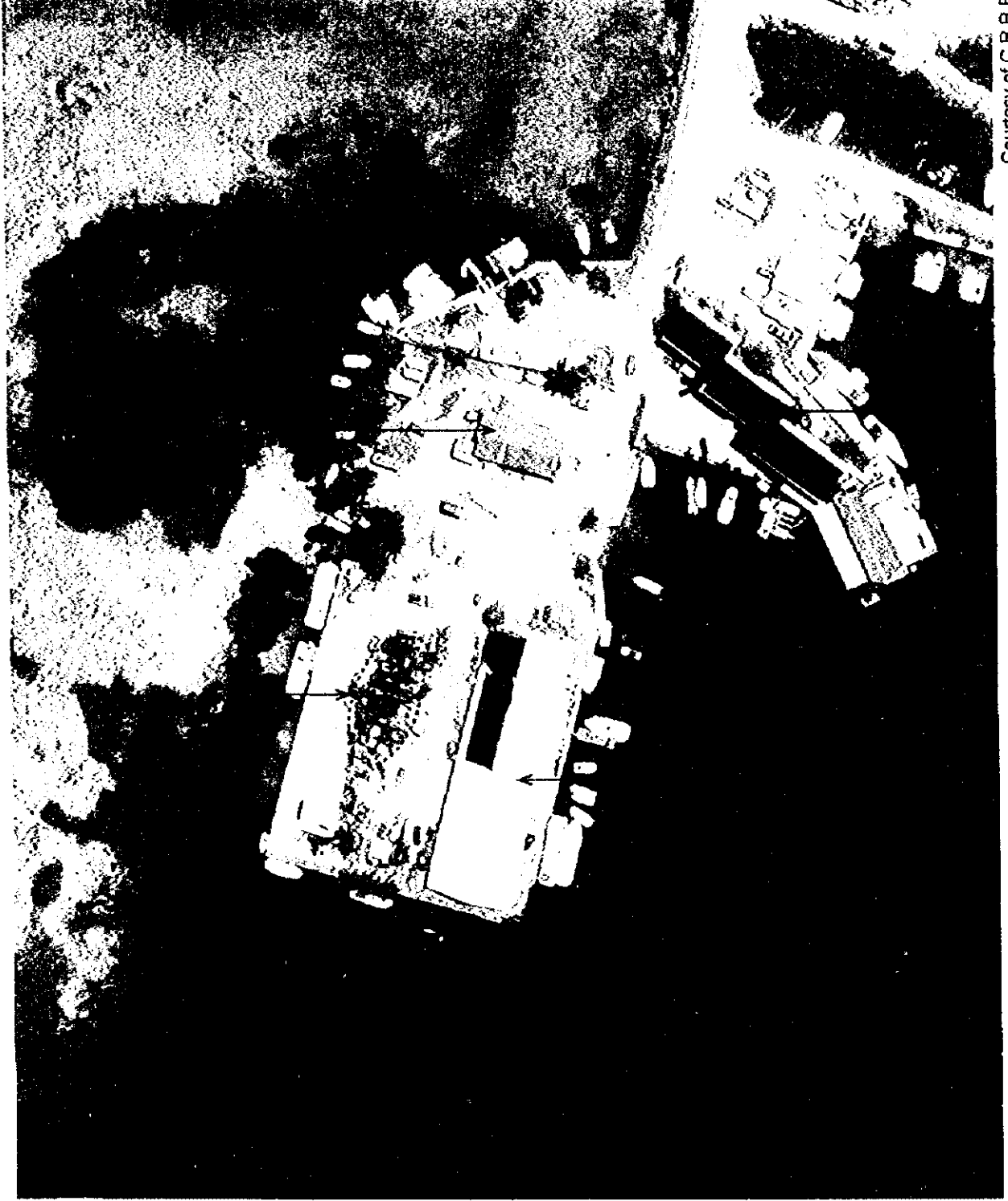
■ **Aerial Photograph - 2** (A distance view showing the relative locations of the Project site, dump site and access road)

Courtesy of C R R F



Aerial Photograph - 2 - A satellite view showing the relative locations of the Paper site, dump site and access road.

Courtesy of C. F. E.



■ **Aerial Photograph - 3** (A close-up view of the Project site)

Courtesy of C R R F





■ Aerial Photograph • 3 (A close-up view of the Project site)

Courtesy of C.R.R.F.

## **List of Abbreviations**

<b>B/D</b>	<b>Basic Design Study</b>
<b>CIP</b>	<b>Capital Improvement Program</b>
<b>CRRF</b>	<b>Coral Reef Research Foundation</b>
<b>GCRMN</b>	<b>Global Coral Reef Monitoring Network</b>
<b>EDP</b>	<b>Economic Development Plan 1995-1999</b>
<b>EQPB</b>	<b>Environmental Quality Protection Board</b>
<b>ICRI</b>	<b>International Coral Reef Initiative</b>
<b>JICA</b>	<b>Japan International Cooperation Agency</b>
<b>JOCV</b>	<b>Japan Overseas Cooperation Volunteers</b>
<b>NMDP</b>	<b>National Master Development Plan 2020</b>
<b>OFCE</b>	<b>Overseas Fisheries Cooperation Foundation</b>
<b>PCC</b>	<b>Palau Community College</b>
<b>PCS</b>	<b>Palau Conservation Society</b>
<b>PMDC</b>	<b>Palau Mariculture Demonstration Center</b>
<b>PNCC</b>	<b>Palau National Communications Corporation</b>
<b>PPUC</b>	<b>Palau Public Utility Corporation</b>
<b>PVA</b>	<b>Palau Visitors Authority</b>
<b>TNC</b>	<b>The Nature Conservancy</b>
<b>TWG</b>	<b>Technical Working Group on the Coral Reef Research Center Program</b>



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## **Chapter 1 Background of the Project**





# Chapter 1 Background of the Project

## 1.1 Background of the Project Requested

The Republic of Palau is an insular country comprising more than 300 islands with a total land area of 488km<sup>2</sup> and a total population of about 18,000 people. In the aftermath of W.W.II, it was designated as a trust territory of the United Nations and placed under the administration of the United States. It became an independent country under the Compact of Free Association with the United States in October 1994.

The economy of the Republic of Palau is based on a dual structure with a traditional self-sufficient economy and a monetary system. Of the domestic industries, agriculture and fisheries are mainly limited to subsistence levels. The country is largely dependent on imported goods in terms of industrial products. About half of the nation's finance is supported by U.S. economic assistance. In its efforts to achieve a self-sustaining economy, the government of Palau has promoted tourism and fisheries as a regional development priority issue in view of its abundant natural resources, particularly the coral reefs.

In addition to being a habitat for fish and other marine organisms, the coral reefs are also a source of raw materials for quick lime, construction materials, jewelry, etc. In recent years, the areas surrounding the coral reefs have been actively exploited for both fisheries and tourism development, and, as a result, the deterioration of the coral reefs and reef fish resources have become problems. The government of Palau has targeted the coral reefs as the focus of its tourism development strategy, which is one of the mainstays in the plan to achieve a self-sustaining economy. Thus, measures to preserve the coral reefs and their ecosystems, research on their long-term use as a tourism resource, and public awareness activities targeting the residents and the tourists on the need to preserve the coral reefs and other marine resources have become important issues. Against this background, the government of Palau requested grant aid from the Japanese government for their plan to establish a Palau International Coral Reef Center (henceforth referred to as the Center) which would carry out public awareness activities on marine preservation and research activities centered on the coral reefs and their related marine organism.

This Project is part of a common agenda between Japan and the United States. In June 1996 a project formulation study was carried out by the Japanese government through the Japan International Cooperation Agency (JICA). This was followed by a preliminary study, which was conducted in February 1997, at which time the function, management, etc. of the Center were discussed between the Japanese, US and Palauan representatives. The results of these discussions were compiled in the "Documentation" which was reviewed by each country and the "Minutes of Discussion" were exchanged between Japan and the Republic of Palau, confirming that the Project-related items requested by the Palauan side

were in agreement with the recommendations contained in the “Documentation”.

## **1.2 Summary of Facilities and Equipment Requested**

**Facilities:** Construction of an educational facility, a research facility and a visitor center.

**Equipment:** Provision of survey boats, motor vehicles, experimental and research equipment (water tanks, water quality checker, etc.), educational equipment (dissector, audio-visual equipment, etc.), office equipment (copy machine, computer, etc.), etc.

## **Chapter 2 Contents of the Project**



## **Chapter 2 Contents of the Project**

### **2.1 Objectives of the Project**

Conservation of nature is one of the three key development goals promoted by the NMDP, together with per capita economic growth and its equitable distribution. In addition to being an abundant source of diverse marine organisms, the coral reefs of Palau and their ecosystem are also resources of the tourism industry. In recent years, the tourism industry has shown a high growth, with an average annual growth rate of 12.5% in the number of visitors into the country and of 6% in the number of hotel rooms, both during 1992-1996. In FY1997, the tourism industry accounted for 46.8% of the GDP and it has become the nation's foremost industry. However, legal measures and organization of systems targeting coral reef conservation have lagged in the face of this growing tourism industry, and hence there are fears that the coral reef ecosystem will deteriorate as development goes on.

The aim of the International Coral Reef Initiative that was advocated by the United States and Japan in 1995 was to achieve sustainability and conservation of the coral reef ecosystem through comprehensive coastal resource management. In this context, the Republic of Palau can be the most appropriate base for coral reef research in Asia and the Pacific.

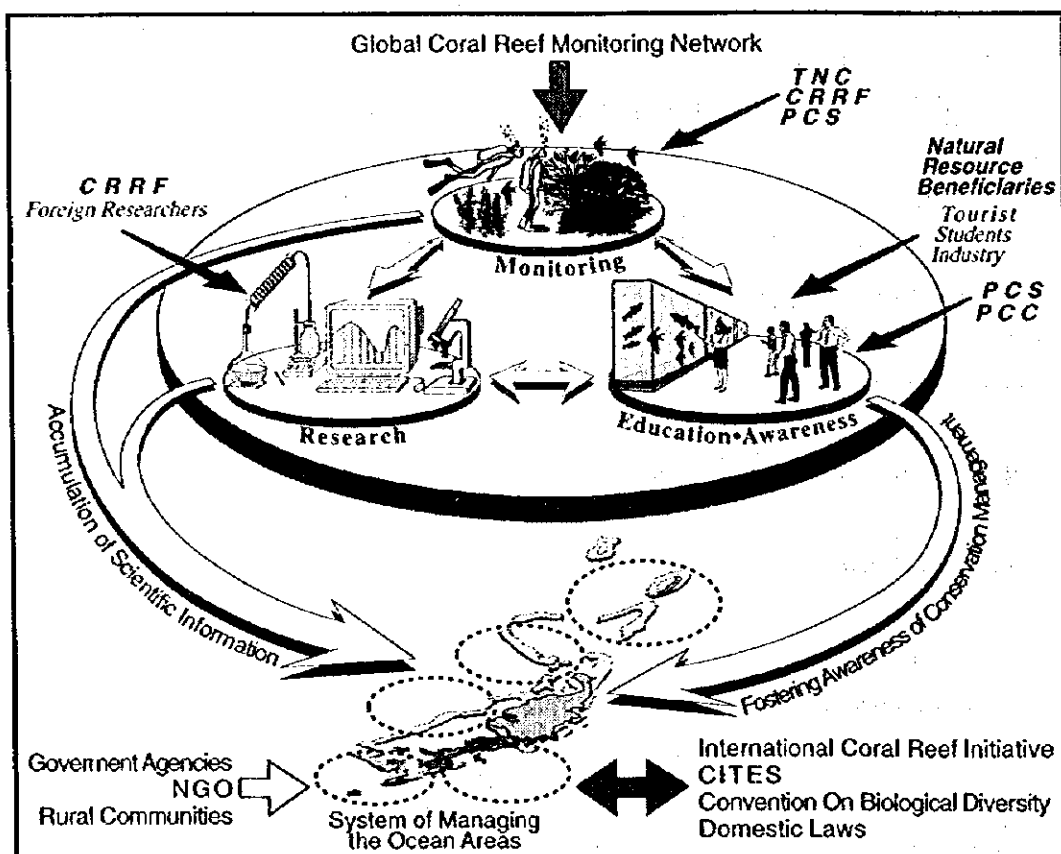
The objective of the Project is to make progress in the research technology for coral reef conservation and to enhance the conservation awareness targeting the Palau residents and foreign tourists through providing "a system of coral reef ecosystem research" and "a system of education and public awareness activities for coral reef conservation targeting the Palauan residents, tourists and people in the Pacific region" by establishing the center in Palau.

### **2.2 Basic Concept of the Project**

#### **2.2.1 Basic Activities of the Coral Reef Center**

In order to achieve the above-described objective of the Project, the basic activities of the Center will comprise "research in coral reef ecosystem" and "public awareness activities for the conservation of coral reefs" and the Center will be endowed with functions of information collection and dissemination to promote these activities. The research and public awareness activities will be interrelated closely, finding of one side being fed to the other to contribute to its repletion. In the present Project, a coral reef center will be constructed to fulfill these functions within a scope manageable and maintainable by Palau. As will be explained in section "2.2.4 Administration Plan", the Center's organization will consist of three divisions (research, education and public awareness, and administration).

In research, study subjects that benefit Palau will be given priority, but issues pertaining to global-level coral reef conservation will also be included among the research topics. As part of the Center's education and public awareness activities, an aquarium exhibition, which is an effective means of drawing visitors (Table 1), will be included in the Project, paying attention to keep its operational cost within the Center's financial capability. In addition, the Center will provide biology education/training classes for elementary pupils and students and promote dialogues with the local populace to educate and disseminate the importance of coral reef conservation throughout the country. Education/training at the Center for people in the Pacific region will not be included in the activities of the Center during initial years of the Center's operation, but will be included after its operation becomes functional technically and financially. The aquarium exhibits will be integrated with the other exhibits such as specimens, models, etc. These combined exhibits will provide an easy-to-understand explanation of the interrelationship between human activities and the coral reef ecosystem, and thus raise the visitors' awareness of conservation.



**Basic Functions of the Palau International Coral Reef Center**

## **2.2.2 Research Plan**

### **(1) Issues Pertaining to Research**

Discussions were held with Palauan side on the Center's research activities based on the proposed research plan in TWG's Concept Paper, the Minutes of Discussion in the preliminary survey of the Basic Design Study, and the plan prepared by this Study Team. It was decided that the Center's research should focus on topics that contribute directly to the conservation of Palauan coral reefs and their ecosystem and, at the same time, can be conducted in the Palauan field. Aquaculture research was basically restricted to subjects on the propagation of hermatypic corals and soft corals as a part of the coral reef restoration efforts, in view of the existence of an Aquaculture research institute in Palau (PMDC), the large-scale facilities and the high technical levels required to conduct research on fin-fish seed production/culture, and the lack of a strong exigency to begin such research now in Palau in the present situation of aquaculture in the world.

### **Research Activities Targeted by the Project**

- A. Primary functions that will be carried out with the commencement of the Center, mainly by Palauan researchers in the near future.
  - 1) General oceanographic observations
  - 2) Monitoring of coral reef ecosystem
  - 3) Research on the management of marine protected areas
  - 4) Research on coral reef fishery resource management
  
- B. Research which may be carried out by Palauan and/or foreign researchers in future when its implementation become possible.
  - 5) Research on biodiversity in coral reef environments
  - 6) Research on the dynamics of coral communities
  - 7) Research on endangered, endemic and rare species
  - 8) Research on the conservation of tropical island ecosystem
  - 9) Research on the restoration of coral communities  
(including propagation of hermatypic corals and soft corals)
  - 10) Research on the rise in sea level caused by global warming and coral reef ecology

### **Future Potential Research Themes (external to this Project)**

- 11) Research on aquaculture (other than corals)
- 12) Biochemical study of coral reef organisms
- 13) Research on toxic marine organisms
- 14) Research on culture and socioeconomy



The research subjects enumerated above, including future potential research themes, include all the themes indicated in the Concept Paper mentioned earlier. It is desired that the Center evolves into an internationally recognized strategic research base, capable of collecting and transmitting information on research and conservation activities pertaining to coral reefs and their ecosystem of the South Pacific.

## (2) Research System and Activity Plan

Presently, there are three Palauans who are knowledgeable on the marine biology and are engaged in research and/or educational activity at PCC. In addition, there are currently two students studying in this field in foreign countries. However, there are no Palauan researchers who have a doctorate degree, and it is difficult to rely solely on Palauan researchers to carry out the Center's research activities so far as during initial years of the Center's operation.

Therefore, it is necessary to foster Palauan researchers through technical cooperation programs. For the time being, one Palauan will be assigned as researcher, who will be given technical assistance by countries which have research achievements in this field, until he/she achieves a certain level of expertise needed to undertake the research activities unaided in curriculum A.

In addition, a place will be provided for foreign researchers who wish to participate in the research activities of curriculum B. During this period, technology transfer activities will be carried out for Palauan researchers. The research activity plan shown in following figures has been compiled based on such factors as the degree of difficulty in learning the research methods, the timing in obtaining research results, the degree of difficulty of the research content, etc.

## Research Activity Plan of the Palau International Coral Reef Center (1/2)

Category A: Primary functions that will be carried out with the start of the Center, mainly by Palauan researchers in the near future

Research theme	Contents	Schedule(year)										Person in charge Remarks			
		1	2	3	4	5	6	7	8	9	10				
<b>1. General oceanographic observations</b>	Daily measurement of specific gravity, temperature, wind force/velocity, atmospheric pressure, surface water temperature, etc. at the site and data recording in the form of monthly statistics.														Palauan researchers: Cooperation with the EQPB
<b>2. Monitoring of coral reef ecosystem</b>	Identification of coral species														Palauan researchers: Technical transfer by an expert.
a. Identification of coral species	Identification of basic species required in monitoring surveys.														-ditto-
b. Survey on the coverage of coral communities in reef margins (Manta survey method)	Preparation of coral skeleton specimens. Location of coral communities using GPS, measurement of coverage, diagramatization/analysis of data														-ditto-
c. Study on the distribution of lagoon bottom characteristics based on analyses of aerial color photograph	Determination of the stratification, coverage and dominant species of corals through aerial photograph analysis														-ditto-
d. Permanent transect survey	Location selection and setting up of transect, survey/analysis of coral and seaweed distribution.														-ditto-
e. Survey on distribution of fish species	Survey and analysis of fish community by transect.														-ditto-
<b>3. Management of marine protected areas</b>	Evaluation of marine areas														-ditto-
a. Evaluation of marine areas	Evaluation of marine areas according to species diversity, rarity, and natural conditions														-ditto-
b. Formulation of marine conservation plan	Selection of marine areas for conservation based on evaluations of land/ sea environmental conditions and socioeconomic factors.														-ditto-
<b>4. Management of coral reef fishery resources</b>	Survey of the distribution, stock quantity and ecology (especially reproductive ecology of major fishery species).														-ditto-
a. Survey on available fishery resources.	Formulation of management plans based on the data above and adjusting to marine conservation plans.														-ditto-
b. Formulation of management plans on coral reef fishery resources	Formulation of management plans based on the data above and adjusting to marine conservation plans.														-ditto-

Notes: ■ Technology transfer and research activities carried out mainly by foreign experts, \*\*\*\*\* Transition period to Palauan researchers, ■ Research carried out mainly by Palauan researchers.  
 Remarks: <1: Tentative evaluation and planning based on existing data. <2: Review of evaluation and planning based on results of researcher activities.

### Research Activity Plan of the Palau International Coral Reef Center (2/2)

Category B: Research which may be carried out by Palauan and/or foreign researchers in future when its implementation becomes possible

Research theme	Contents	Schedule(year)										Remarks		
		1	2	3	4	5	6	7	8	9	10			
<b>5. Research on biodiversity</b> a. Study on coral fauna	Elucidation of coral species composition in each other area; to be conducted together with 2 a. and b.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Certain research results are desired to be obtained at a relatively early period.
b. Study on fish fauna	Elucidation of fish species composition in each area; to be conducted together with 2 a. and b.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	-ditto-
<b>6. Research on dynamics of coral communities</b> a. Research on coral propagation and survival	Accumulation of data on coral reproductive ecology, dispersal and settlement of larvae, and recruitment and survival	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Data applicable in coral reef conservation in Palau as well as in other areas are expected.
b. Research on the transition of coral	Analysis of the transition mechanisms of coral community structures based on studies of natural and human disturbances and data from 5a.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
<b>7. Research on endangered, endemic, and rare species</b>	Examination of conservation/protection measures from ecological and sociological viewpoints.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Studies in relation to human activities and the transition of natural conditions are expected.
<b>8. Research on the conservation of tropical island ecosystem</b>	Studies of conservation measures based on the correlation between land and marine ecosystems and human activity impacts on the ecosystems.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Studies should be conducted corresponding to development stages in Palau.
<b>9. Research on the restoration of coral communities</b>	Restoration of corals through sexual and asexual reproduction.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Information similar to 6a. and b. are expected.
<b>10. Research on the rise in sea level caused by global warming and coral reef ecology</b>	Examination of the extent of the rise in sea level and its impact to the coral reef ecology	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	-ditto-

Notes: ..... Research carried out by both Palauan and foreign researcher, but the scheduling will be based according to availability of fund and foreign researchers.

(3) Research scheme

Curriculum A will be given priority among the research activities undertaken by the Center. It is expected that curriculum A activities are carried out by one Palauan researcher and one foreign expert who will be responsible for transferring the technology to the Palauan researcher. In addition, at least one research assistant, who will be concurrently responsible for piloting the boat, will be recruited. Specified researchers will not be assigned to curriculum B activities, but the facility will be capable of accommodating one to two researchers (research rooms and accommodation quarters) who wish to use the facility to carry out the research for curriculum B activities. The facility will accommodate a researcher-in-residence that will be responsible for advising research activities from a broader perspective, in order to develop the Center into an international research facility. A minimum of three research rooms (each will be for common use when necessary) and three accommodation quarters will be provided in the research building. One dry laboratory and one specimen room will also be installed in the building. As for rearing experiment, some space of the maintenance room of the Visitor Center will be shared as an indoor wet lab, and an outdoor tank facility will be provided. Due to the frequent number of underwater surveys, two boats (one for long distances and one for short distances) and diving equipment will be provided.

### 2.2.3 Education and Public Awareness Plan

(1) Education and Public Awareness Themes

The aims of the Center's education and public awareness functions are 1) to provide specified students, technicians, researchers and local volunteers with opportunities of education and training in coral reef research and conservation, and 2) to raise the awareness of the general populace, tourists, etc. on the importance of environmental conservation.

1) Education and training activities

As an educational and training facility for coral reef conservation, the Center is expected to function not only as a local center but also as a regional center for the Pacific region. Its activities are outlined as follows:

- a. Provide lectures and laboratory/field practices for elementary, secondary school, and junior college students as extracurricular education.
- b. Provide lectures and training seminars for teachers, tourist industry personnel (tour guides, etc.), local supporters (environmental conservation groups, volunteers, etc.).
- c. Provide field research and training activities for students, trainees, technical

experts from Palau and the Pacific region.

- d. Provide on-the-job training for the Center's Palauan staff members and staff candidates.

Of the activities listed above, a. and b. will be carried out at the multipurpose room and the training/experimental laboratory. This laboratory will also be used for lectures. Activities for c. and d., mostly individual activities in their nature, will be carried out at both the research building and Visitor Center. Of the field research and training activities of item c., those for participants from the Pacific region other than Palau will have to be limited to individual research activities due to constraints in the personnel and financial resources of the Center during the initial period after its establishment. Group training for c. may be possible in future when the Center becomes viable both financially and technically.

## 2) Public awareness activities

The Visitor Center will be the focus of the facility's public awareness activities as listed below.

- a. Exhibits: The exhibits will be created based on the following basic concept.

The Palauan Islands are blessed with diverse ecosystems represented among others by coral reefs, and the people have benefited greatly from the natural resources. The inhabitants of these islands have reaped the bounty of the diverse ecosystems for many generations while skillfully living in harmony with the natural environment. The Visitor Center aims to educate and solicit, through its varied exhibits, the understanding of visitors on the diverse ecosystems and on the close relationship between the coral reefs and the culture and lifestyle of the island inhabitants, and thus raise the people's awareness of the value of the coral reefs, the importance of coral reef conservation, and the need for sustainable coral reef management.

- b. Interpretation: Guide to the contents and significance of the exhibits will be provided by staff members and by means of audio guidance sets.
- c. Information for field observations: Manners and rules for coral reef protection and information related to diving and diving spots will be provided.
- d. Lectures, field trips and publications.
- e. Sales of environmental goods at the museum shop.

Of the activities listed above, the museum shop is anticipated to become one of the Center's major sources of revenue. Foreign technical assistance is needed to develop and sell attractive products.

(2) Activity plan

Although the entire staff of the Center will be engaged in the education and public awareness activities mentioned above, the cooperation of existing educational institutions, organizations related to environmental conservation, volunteers, and others in Palau is badly needed, and functional operation of the Center will not be possible without such cooperation. Fortunately, the cooperation of PCC, PCS, CRRF and other institutions which have hitherto participated in environmental conservation can be counted on for education/practice activities for elementary pupils and students, and the cooperation of visiting researchers and technical cooperation experts, as well as these institutions, can be anticipated for individual training activities. Cooperation from volunteers in public awareness activities such as lectures and commentaries is also expected.

Education and public awareness activities should commence with the start of the Center. In particular, the exhibits, information dissemination and retail activities of the Visitor Center should be fully operational at its initial start. In order to achieve this, staff training must be adequately conducted during the preparation phase prior to the Center's commencement, and technical transfer and cooperation plans with relevant institutions that carry out these activities must be consolidated beforehand. Adequate time should be allocated for technical assistance, primarily for the rearing of aquatic organisms, maintenance and operation of rearing facilities/equipment, and development of goods for sale at the museum shop. The Public Awareness and Education Plan is shown in the following figure.

**Public Awareness and Education Activity Plan of the Palau International Coral Reef Center**

Activities	Contents	Schedule (year)										Person in charge Remarks		
		1	2	3	4	5	6	7	8	9	10			
<b>1. Exhibition of marine organisms</b> a. Basic	Live corals, other invertebrates and fishes will be displayed in the aquarium.		■											Curator: Cooperation with experts, CRRF, PMDC, etc.
	b. Applied techniques				■									-ditto-
<b>2. Information Supply</b> a. Information required for field observation.	Coral reef restoration activities will be carried out. Display of the ecology of symbiosis.				■									Curator: Cooperation with experts and private parties
	Conservation regulations, diving information, etc. will be disseminated to visitors.			■										Curator: Cooperation with PCC, PCS, CRRF, TNC, etc.
<b>3. Explanations, lectures, public actions</b>	Hold observation gatherings and lectures for students and private citizens. Publish public awareness pamphlets.			■										Curator: Cooperation with the PCC, PCS, TNC, CRRF, PVA
	Training programs for teachers, tourist industry personnel, diving related personnel				■									Curator: Cooperation with the PCC, PCS, TNC, CRRF
<b>4. Education, training</b> a. Training	Conduct field trips for primary and high school students.													-ditto-
	Activities to foster staff members in natural conservation and volunteer instructors.													Curator, researcher, Director: Domestic and foreign related institutions
<b>5. Coordinate activities with related institutions</b>	Create a framework for coral reef conservation and promote conservation activities.													Curator, researcher, Director: Domestic and foreign related institutions

Notes: ■ Technology transfer and activities carried out mainly by foreign experts. □ Activities carried out mainly by Palauan staff.

(3) Number of users to the Visitor Center

The following two types of users are anticipated to visit the Visitor Center.

- Visitors who pay to see the exhibits (foreign tourists and Palauan residents).
- Visitors who utilize the facility for practical studies in marine organisms and to receive training in coral reef conservation (elementary pupils/students, tourist guides/ diving instructors, local citizens, inhabitants of the Pacific region, etc.).

1) Estimated admission revenue and number of visitors

The admission fees of the Visitor Center, which are an important source of revenue for the Center, will be determined according to the number of visitors as well as the scale of the exhibits and their contents. The visitors will be composed of Palauan inhabitants and international tourists. The Palauan resident population is small, amounting to about 18,000 only (1997), and the annual population growth rate is 2.6%. In contrast, the number of visitors to Palau (out of which 92% was tourists) in 1996 was 69,000, indicating a high 12.5% growth rate from 1992 to 1996. In the estimation of the number of visitors to the Visitor Center in this report, the tourist growth rate is considered, but the Palauan population growth rate according to the 1995 census is not. The major segment of the tourist population in Palau consisted of Americans and Japanese in the past, but the number of tourists from Taiwan has increased in recent years, with an annual growth rate of 53%. Meanwhile, the annual increase in number of hotel rooms has been only 6% due partly to the environmental restrictions established by the government and other conditions. Since long-term forecasts are unrealistic under such circumstances of hotel accommodation, the number of visitors is estimated only for the initial five year period from 2000, when the Center is targeted to start operations, to 2004, based on the growth rates of visitors for non-Taiwanese and on the growth rate of hotel rooms for Taiwanese visitors. In order to grasp the preferred activities of the tourist population from different countries, an interview survey targeting departing tourists at the Palau International Airport was conducted, and the results are reflected on the estimation of the number of visitors and admission revenue. In addition, the number of visitors and revenue estimation for different cases of visitor increase rate is also made, in view of the possible prolongation of the ongoing worldwide economic depression (see Appendix I.1 "Projection of Admissions and Revenue of Visitor Center, and Sales of Museum Shop").



### Projected Number of Visitors and Revenue from Admission of Visitor Center

Assumption of Growth Rate of No. of Visitors to Palau	Year	No. of Visitors to Palau (persons/year)	No. of Visitors to the Center (persons/year)	Revenue from Admission Fee (US\$/year)
Case 1: Based on the mean annual increase rate for the past five years (1992-1996) by countries.	2000 <sup>&lt;1</sup>	93,292	54,977 (53,448) <sup>&lt;3</sup>	229,413 -
	2004 <sup>&lt;2</sup>	125,458	73,813 (72,284) <sup>&lt;3</sup>	312,858 -
Case 2: Same growth rate as in Case 1 1999-2000, and for 2001- 2004 a 1/2 rate.	2000 <sup>&lt;1</sup>	93,292	54,977 (53,448) <sup>&lt;3</sup>	229,413 -
	2004 <sup>&lt;2</sup>	108,262	63,726 (62,197) <sup>&lt;3</sup>	268,032 -
Case 3: Same growth rate as in Case 1 1999-2000, and a zero (0) for 2001-2004)	2000 <sup>&lt;1</sup>	93,292	54,977 (53,448) <sup>&lt;3</sup>	229,413 -
	2004 <sup>&lt;2</sup>	93,292	54,977 (53,448) <sup>&lt;3</sup>	312,858 -

Remarks <1: At the time of Center's opening.

< 2: After 5 years

<3: No. of foreign visitors to Visitor Center

#### 2) Estimated number of participants in practice and training for Palau residents

The student population of the entire country for 2004 is estimated at 3,380 students, i.e. 2,584 elementary pupils and 794 secondary students (The Palau 2000 Master Plan for Education Improvement). The educational system in Palau comprises eight years of primary school and four years of secondary school. On the assumption that these students visit the Visitor Center at least twice during the primary school period and twice during the secondary school period, the annual number of students engaged in lab/field practice courses is estimated to be 1,054 (86 students/month: 25 students per class, four times a month). In addition, a total of about 40 PCC students from the Science Center and the Tourism Course are assumed to visit the Visitor Center several times a year to participate in study/training classes.

The training seminars will mainly target tourist guides, diving instructors, etc. As of 1997, 57 tourist agencies have been registered in Palau and there are an estimated 200 tourist guides and instructors in the tourism business. The PVA is planning to establish a license system for tourist guides, and with the cooperation of the Center, there is the possibility that training seminars in coral reef conservation will become a requirement for tourist guides. If this undertaking is realized, an additional 20 participants will be joining, in view of a possible 10% annual increase in number of tourist guides/instructors to meet the growing number of tourists.

Presently, PCS is implementing environmental conservation activities at the community level, but its activities have been restricted due to the lack of an adequate assembly hall. PCS has signified its interest in using the Center's facilities for such

activities when it opens. If this idea is materialized, approximately 50 to 100 people are estimated to attend these activities at least twice a month. As a result, about 1,200 to 2,400 people are anticipated to use the Center facilities annually for these PCC activities.

### 3) Anticipated sales of the Visitor Center museum shop

The revenue generated by the museum shop is calculated according to the following formula:

$$\text{Sales} = \text{number of visitors} \times \text{average purchase amount per visitor}$$

The average purchase amount per visitor at nine public aquarium in the United States is US\$2.13 in mean and US\$1.92 in median value (pers. info., Mr. Kuroda, Waikiki Aquarium). The average purchase amount per visitor recorded at the Palau National Museum is US\$5.00 (data obtained from sales in March 1997). In view of the facts that the purchase amount of souvenir gifts by tourists in Palau, excluding Taiwanese tourists, is high, that divers visiting Palau also show the same tendency as the general tourist, and that there is no rival attraction facilities in competition with the Center, an average purchase amount per visitor is set at US\$2.50 (see Appendix I.1 "Projection of Admissions and Revenue of Visitor Center, and Sales of Museum Shop").

Based on this supposition, the sales of the museum shop are anticipated as follows.

Projected Sales Revenue from Museum Shop

Assumption of Growth Rate of No. of Visitors to Palau	Year	No. of Visitors (persons/year)	Sales Revenue (US\$/year)
Case 1: Based on the mean annual increase rate for the past five years (1992-1996) by countries.	2000 <sup>&lt;1</sup>	53,448	133,620
	2004 <sup>&lt;2</sup>	72,284	180,710
Case 2: Same growth rate as in Case 1 for 1999-2000, and an 1/2 rate for 2001-2004	2000 <sup>&lt;1</sup>	53,448	133,620
	2004 <sup>&lt;2</sup>	62,197	155,493
Case 3: Same growth rate as Case 1 for 1999-2000, and a zero (0) for 2001-2004.	2000 <sup>&lt;1</sup>	53,448	133,620
	2004 <sup>&lt;2</sup>	53,448	133,620

Remarks <1: At the time of Center's opening.  
<2: After 5 years

### 4) Other anticipated revenue

In order to make the Center is in principle a financially independent, the revenue derived from the Visitor Center seems to be insufficient. Therefore, the

Center must strive to generate revenue from sources other than the Visitor Center. During the tripartite discussions held between Palau, Japan and the United States in the preliminary study phase and during this B/D study, the following potential sources of revenue were reviewed.

		Unit: US\$/Year
(i) Glass-bottom boat rental	250 ~ 400,000	-
(ii) Bench fee (\$40/day) (\$25/day)*	80,000	7,000*
(iii) Housing (\$25/day x 200 days)	-	5,000*
(iv) Research grants	250,000	0*
(v) Tax subsidies (Hotel tax, diving tax, etc.)	63,000	-
(vi) Membership fee (\$10/person/year x 1,000 people)	10,000	-
(vii) Certification fee	-	0*
(viii) Facility rental (\$200/time x 100 times)	-	2,400*
(ix) Vending machine net profit (\$0.16/can x 3,870 people x 1/10)	-	621*
(x) Boat usage (\$200/time x 100 times)	-	20,000*

Remarks: a) \* indicates the estimated value given in the comments by US side for the Interim Report.

b) Items without an asterisk show the estimated value given in the tripartite discussions during the preliminary study phase.

Based on the research and the education and public awareness plans described earlier, the amount of revenue generated from these potential sources during five years following the Center's commencement is projected as shown in the following table (see appendix I.2 "Other Estimated Revenue of the Center").

Potential revenue source	Projection of Revenue from Other Sources in the Center					Unit: US\$
	Year					
	2000	2001	2002	2003	2004	
(i) Glass-bottom boat rental	No plan	No plan	No plan	No plan	No plan	
(ii) Bench fee	1,980	(2,970)	3,960	(6,930)	9,900	
(iii) Housing	1,200	(1,800)	2,400	(4,200)	6,000	
(iv) Research grants	-	-	-	-	-	
(v) Tax subsidies	-	-	-	-	-	
(vi) Membership fee	220	440	660	880	1,100	
(vii) Certification fee	-	-	-	-	-	
(viii) Facility rental	1,200	1,200	1,200	1,200	1,200	
(ix) Vending net profit	880	946	1,018	1,096	1,181	
(x) Boat usage	3,000	(4,500)	6,000	(10,500)	15,000	
Total	8,480	11,856	15,238	24,806	34,381	

Remarks: - : Revenue to be generated in future and not in the initial period of operation.

( ): Figures in parentheses refer to the average of the preceding and subsequent years.

(4) Education and public awareness activities

The Visitor Center will have marine organism exhibits as part of the Center's public awareness activities to promote coral reef conservation among the Palauan citizens and foreign tourists. The Visitor Center will cover an area of approximately 300m<sup>2</sup>, based on a calculation standard [see 2.3.2 (2) Building plan] using the estimated number of visitors per year which was anticipated to remain under 100,000 visitors annually (see Appendix I.1). In view of the planned number of exhibit tanks and ponds, water volume, quantity of marine organisms to be stocked, one aquarist is adequate to oversee these tasks. However, two aquarists will be employed to allow them to alternate their days off since the Center will be in operation throughout the year. A minimum of two cashiers is needed to handle admission ticket sales and the retail activities of the museum shop. However, 3.5 cashiers will be employed considering work on Saturdays and Sundays (in the organization system, the cashiers are allocated in the administration section as described in the following section). In the Visitor Center a training/experimental room will be provided to accommodate courses for elementary and secondary students, and a multipurpose room will be provided for various workshops and assemblies. In order to supervise such education/public awareness activities from a technical standpoint, a curator and an education assistant will be employed.

#### **2.2.4 Administration Plan**

The Center will be managed as a public corporation with a self-supporting accounting system. Hence careful attention must be paid to revenue and expenditures.

The Director is not only responsible for overseeing the revenue from admission fee and museum shop sales, but to procure other sources of revenue by effectively utilizing the Center's facilities. He/she will also be responsible for achieving stable operations of the Center by securing research subsidies from abroad in future. In addition, one of his/her duties will be to attend international conferences, etc. The task of compiling request documents for subsidies from assistance organizations will be contracted to outside professional parties for the time being and the Director will be in charge of overseeing this task.

For the maintenance of the research and education/public awareness facilities, the Administration division will have minimal staff members as shown below:

- Director (1)
- Secretary (1)
- Financial Officer (1) (concurrently in charge of the museum shop's operation)
- Clerk (1)
- Mechanic (2) (one intermediate class and one assistant)
- Janitor (1.5) (alternate Saturday/Sunday shifts considered)
- Night security guard (1.5) (alternate Saturday/Sunday shifts considered)

### 2.2.5 Technical Cooperation Plan

(1) Technical capability required for the Center's professional posts and technical cooperation

For the efficient operation of the Center, capable Palauan staff members should be selected and recruited from candidates who have educational backgrounds in biology, oceanography, marine biology, rearing of aquatic organisms, environmental protection, etc. and/or who are experienced in research activities in these areas or in organizational management. Past surveys have indicated that it is possible to recruit Palauan candidates, including those who are studying or working abroad at present, who have potential capabilities that can be fostered over time. However, candidates with actual work experience in museums, aquariums, etc. seem to be few in numbers. Therefore, technical cooperation in all relevant areas such as organizational management, research, rearing of aquatic organisms, etc. is required for a long term (about 10 years) beginning prior to the Center's opening. Major forms of technical cooperation are the dispatch of experts to Palau and training abroad.

The contents of the technical cooperation needed for the time being are outlined below:

1) Organizational management and international promotion (targeting the Director)

Technical cooperation for the Director during initial years of the Project will aim at developing of management/coordination abilities and skills, focusing on the operation of the Center in cooperation with relevant domestic institutions and the development of cooperative ties with research and supportive institutions abroad. Then technical cooperation will be continued for fostering skills in evaluating coral reef resources and planning and implementing integrated coastal resource management plans. Additional activities include introducing the Center's achievements to international congress/meetings and others, expanding the use of the Center's facilities, improving public relation skills needed to secure government subsidies.

2) Coral reef monitoring and ecosystem surveys (targeting the Senior Researcher)

Short-term technical transfer will focus on learning the methodology to monitor the coral reefs and establishing a monitoring system/method suited to Palau. This will be followed by technical transfer activities related to marine environment protection and management. After a certain level of results is achieved in monitoring and research activities, assistance will be provided for a Master's or higher degree.

3) Management of the Visitor Center (targeting the Curator)

Technical cooperation will first be provided in public aquarium operations, exhibit techniques, educational techniques, and basic techniques of aquatic organism rearing. As medium-range activities, technical transfer will be made for improving the leadership skills needed to foster personnel participating in the environmental conservation movement and the operation/management of the Visitor Center. In addition, assistance will be provided for a Master's or higher degree.

4) Rearing of aquatic organisms (targeting the Chief Aquarist)

The first-step subject of technical cooperation will be basic aquarium rearing techniques of a level that the daily aquarium rearing activities are not disrupted. The level of training will be elevated to rearing techniques for organisms difficult to maintain in captivity and knowledge and skills related to ecological exhibition. Assistance will be provided for a degree of MS level.

5) Facility maintenance (targeting the Chief Mechanic)

Skills needed to maintain all Center facilities, including aquarium-rearing facilities, will be transferred.

6) Management of the museum shop (targeting the Financial Officer)

Technical cooperation activities will focus on managing the museum shop and improving its sales by product development, purchasing, management of sales, etc.

In addition to these activities, OJT is required for the staff in the actual management of the Center.

(2) Plan of Technical Cooperation through Dispatching Experts and Receiving Trainees

In order to help the Center to function adequately from its initial start, it is necessary to carry out staff and organizational arrangements prior to the Center's commencement. In order to achieve this, experts must be sent to Palau and relevant staff members must be sent to training programs abroad. Proposals based on these considerations are shown in Fig.1 to 4.

The need for technical cooperation from Japan, the United States, and other countries has been acknowledged from the initial reviews of the Project. Potential forms of the cooperation are currently under discussion between Japan and the U.S.

In order to maintain consistency and to enlarge the effectiveness of this type of cooperation, experts should be selected and recruited through close contact with collaborative

such as universities, research institutes, scientific societies and public aquariums. The same principle should be applied for trainees.

The selection of the expert for whom the Director is counterpart should be carefully carried out since the position requires international vision as well as management capabilities.

### (3) Other Technical Cooperation

In addition to the technical cooperation explained above, development of research utilizing the Center by universities and research institutions in Japan, the United States and other countries is essential, in order to upgrade the Center's research levels to international standards. The primary aim of this type of research is not to transfer technology or to contribute greatly to research funds. Participation and cooperation of the Center's staff in such research activities will greatly improve the capabilities of the staff members and may provide them with greater opportunities to study abroad, to earn a doctorate degree through submission of doctorate dissertations, and to participate in international conferences. Ties with universities and research institutions where cooperation may be anticipated through research work should be developed in parallel with the Center's growth.

The Marine Laboratory of the University of Guam and CRRF has already made considerable achievements in research on Palauan coral reef organisms. In addition, public awareness activities on coral reef conservation are currently being carried out by PCS. CRRF and PCS have already indicated their willingness to educate staff members and to provide volunteer services. It is recommended that the relationship with these two institutions be strengthened and developed over the short-term through joint research activities and the utilization of human resources and funds.

## 2.2.6 Facility and Equipment Plan

### (1) Basic Policy of the Facility Plan

#### 1) Policy on the planning of facility function and content

Based on the basic concept on the operations and activities of each component of the Center described in sections 2.2.2 to 2.2.4, the fundamental functions of the Center are ① research, ② education and public awareness, and ③ administration. In order for the Center to fulfill these functions, the minimum required facilities would be provided in this Project.

#### ① Research functions

The basic research facilities which will be provided are three research rooms for use by both Palauan and visiting researchers, a dry laboratory, a wet laboratory (concurrent use as a maintenance room for exhibit at the Visitor Center), a specimen

room, a library, a conference room (to be also used for administration functions), and minimum lodging accommodations for visiting researchers. In addition, a workshop, a shower room, and a storage for materials and equipment will be installed. Outdoor rearing and quarantine tanks will also be provided.

② Education and public awareness functions

Exhibition facilities, as a part of the facilities of education and public awareness functions, include an exhibition room to disseminate messages on coral reef conservation, a maintenance room for the exhibits (concurrently used as a wet lab), and an aquarist room will be located in the Visitor Center. In order to create an attractive exhibit for visitors as a component of the Center's education and public awareness functions, indoor and outdoor tanks and pools for live marine organism and ecological exhibits will be set up, in addition to displays of preserved specimens, panels, etc. Facilities for filtration and other water treatment necessary for aquarium exhibition will be installed.

A multipurpose room for special exhibit programs, workshops, assemblies, and other functions, and a museum shop, which is anticipated to become a major source of revenue for the Center, will be provided. A training/experimental laboratory will also be created as a part of the Center's education and public awareness functions for use by local elementary and secondary school students for lectures in natural science and extracurricular activities.

③ Administration functions

The facilities to be provided for management and operations of the Center are a Director office, an administration room and a ticket office. Other common facilities include rest rooms and a utility room.

2) Policy on the size of facilities

The size of the facilities has been determined based on the "Compilation of Architectural Design Data" edited by the Architectural Institute of Japan and the "Natural Park Facilities" edited by the National Parks Association. The required floor space of each room was calculated and its scope was set accordingly.

3) Policy on the planning of furniture included in the facility plan

Furniture that is indispensable to fulfill the functions of the facilities will be provided in the Project.



## **(2) Basic Policy on Equipment Selection**

The type, grade and quantity of the equipment that will be provided by the Project will be selected according to the following criteria.

- The equipment necessary to be provide by the time of the Center's opening will be indicated in two lists, one for equipment to be provided by Japanese side and the other for that to be prepared by Palauan side.
- Basically, pieces of equipment required for Category A studies will be the main items to be provided. Equipment, which will enable international communications, will also be considered, to help establish the Center as an information center for coral reef conservation.
- As to the equipment for public awareness functions, items for exhibit functions, education/training functions and public awareness functions at the multipurpose room will be given priority. For cash registering equipment provided for the museum shop, acceleration of work speed will be considered.
- For the determination of administration equipment to be provided, attention will be paid to the efficiency in information processing and usefulness in the repairs and improvements of the facilities by the Center's staff member themselves.
- The quantity of the equipment will be limited to the minimum number of units required at the time of the Center's opening. However, the quantity required for easily damaged equipment and spare parts will be planned.
- The grade of the equipment will be selected based on criteria of precision, salinity-resistance, durability and handling easiness.
- Priority will be given to equipment which can be repaired locally and spare parts of which can be procured locally. Complex equipment that is difficult to replace or to obtain parts will be excluded.

## **2.3 Basic Design**

### **2.3.1 Design Concept**

#### **(1) Policy on Natural Conditions and the Surrounding Environment**

- In view of the highly humid tropical climate, adiabatic factor, ventilation and shade will be considered in the design of the facilities.
- The facilities will be designed to cope with such factors as maximum wind force, tidal levels, etc. Construction equipment and materials will be selected considering their durability against sea air damage and other natural conditions.
- The building height, color, and facade will harmonize with the surrounding environment.

- The design and construction method with the least impact on the environment and the surrounding ocean will be employed.
- The location and layout of the buildings will be determined according to the ground conditions of the site.

## (2) Policy on Construction Conditions

Discussions with CIP are required prior to constructing the facilities. Due to the lack of legal regulations on building structure, fire prevention, etc. in Palau, Japanese standards will be applied. However, because of the existence of environmental standards in Palau, adequate discussions with the EQPB on environmental countermeasures are necessary before the start of construction work.

The capabilities of local construction companies are generally not high, and companies that are reliable in terms of work, quality, and safety factors are limited. Therefore, in order to keep costs from rising, the facility should be designed with clear grade specification. The construction labor force will be mainly dependent on Filipinos, due to the lack of Palauans who will engage in heavy labor. However, the number of workers, even including Filipino workers, is insufficient and construction workers from several local companies will be used in this Project or Filipino workers will have to be recruited directly from the Philippines or other countries.

Construction equipment and materials are also dependent on imported products, and hence there is an insufficient stock of such equipment and materials. The delivery date of the equipment and materials must be confirmed and adequate storage must be secured when the Project is implemented.

## (3) Policy on the Use of Local Construction Companies and Local Equipment and Materials

The local construction companies ranges from those that own heavy equipment to those that function only in supplying construction workers. In any cases, construction companies staffed with technicians are limited. The majority of the technicians are Filipinos as in the case of construction workers, and Palauan technicians are few in number. The level of work is not high, even in construction companies with technicians in their employ. The salaries of Filipino technicians and workers are higher in Palau than in the Philippines, due to the high minimum wage of the Palauans and the high salaries in Guam. Likewise, the unit price of construction is higher in Palau than in Southeast Asia, due to imported equipment and materials and high wages. There is only one company capable of making a shop drawing, illustrating the scarceness of companies possessing the work level of Japanese companies. Construction methods that can cope with the local technology and construction machines will be adopted wherever possible.

Construction equipment and materials will be selected incorporating factors such as objective, durability, cost, etc., and equipment and materials which can be supplied locally will be chosen whenever possible.

**(4) Policy on Operation and Maintenance Capabilities of the Implementing Agency**

The scale and content of facilities will be so determined that the facilities can be managed and maintained adequately by Palauan side, taking into consideration the technical level of staff members in charge of operation and maintenance. Equipment will also be selected according to grade and specifications that will lower maintenance costs (amount of electricity consumption, frequency of the replacements of consumable, etc.).

**(5) Policy on the Grade of Facilities and Equipment**

Facility/equipment plan and design should be minimum in scope and content to fulfill the Center's activities, reflecting the estimated number of visitors, the staffing plan and operation plan. In the selection of equipment, keen attention will be paid to the essential functions that meet the needs of the Center's activities. Sophisticated automated equipment will be avoided, and easy-to-repair equipment will be selected.

**(6) Policy on Construction Period**

Palau has a heavy rainfall and much of the rainfall is in the form of squalls. The construction method to be adopted will take this factor into consideration. In addition, the Project site is narrow and surrounded by the sea in three directions. In order to carry out the construction work of the Center buildings and the renovation work of the existing revetment simultaneously, both work processes must be fully coordinated.

Since most of the construction materials/equipment are imported, the delivery schedule will greatly affect the work period. Hence the stock volume of the needed materials and equipment must be constantly checked to insure that shortages do not occur.

**(7) Policy on Revetment Repairs**

While structurally strong sections of the existing revetment (stone masonry) are planned to be maintained, renovation will be carried out in portions where the revetment are heavily damaged and/or the height of the its crown is extremely low. The renovated structure will allow the revetment to maintain its minimum functions, but its cost will be economical. Work methods in accordance with the repair grade of depreciated or damaged portions will be adopted.

**(8) Basic Policy of the Exhibit Plan**

The major role of the education and public awareness activities of the Visitor Center is to develop the knowledge of the people of Palau and foreign tourists in the diverse ecosystems of Palau, particularly the biodiversity of coral reef ecosystem, in Palau, and to cultivate awareness of the importance of coral reef conservation. In order to fulfill this role, indoor and outdoor exhibit tanks and ponds, photographs, explanatory panels, models, specimens, etc. will be effectively displayed according to scenario.

**2.3.2 Basic Design**

**(1) Site Plan**

**1) Basic concept of site plan**

The facilities will consist of three main elements, i.e., the research building to house research facilities, the Visitor Center for public awareness and education activities, and the administration building for management and operations of the entire Center. The Visitor Center will contain a building to house indoor exhibits and an outdoor exhibit area. Other outdoor facilities will include a rearing tank yard, a rotary and a parking lot. The scope of works to be executed by Japanese and Palauan sides will be delineated in section 3.1.3 Scope of Works. Based on a thorough review of the site conditions, the following factors will be incorporated in the basic concept of the site plan.

- Based on the results of the boring test, the buildings will be located away from the loose ground.
- Zoning based on an easy-to-understand line of movement for visitors, researchers, and administrative staff will be adopted.
- The facility layout will take into consideration the location of the entrance/exit on the East Side of the site and that of the wharf on the northwest side.
- The scenery on the southwest side of the site will be taken fully into consideration in the facility layout. In particular, this natural scenery will be utilized for the outdoor facilities to make the facilities harmonize with the natural scenery.
- Landscape, such as the configuration of the site which juts out to the beautiful Palauan sea and the skyline of the facilities viewed from the Malakal Causeway, will be considered in the configuration and layout of the buildings.

## 2) Facility layout plan

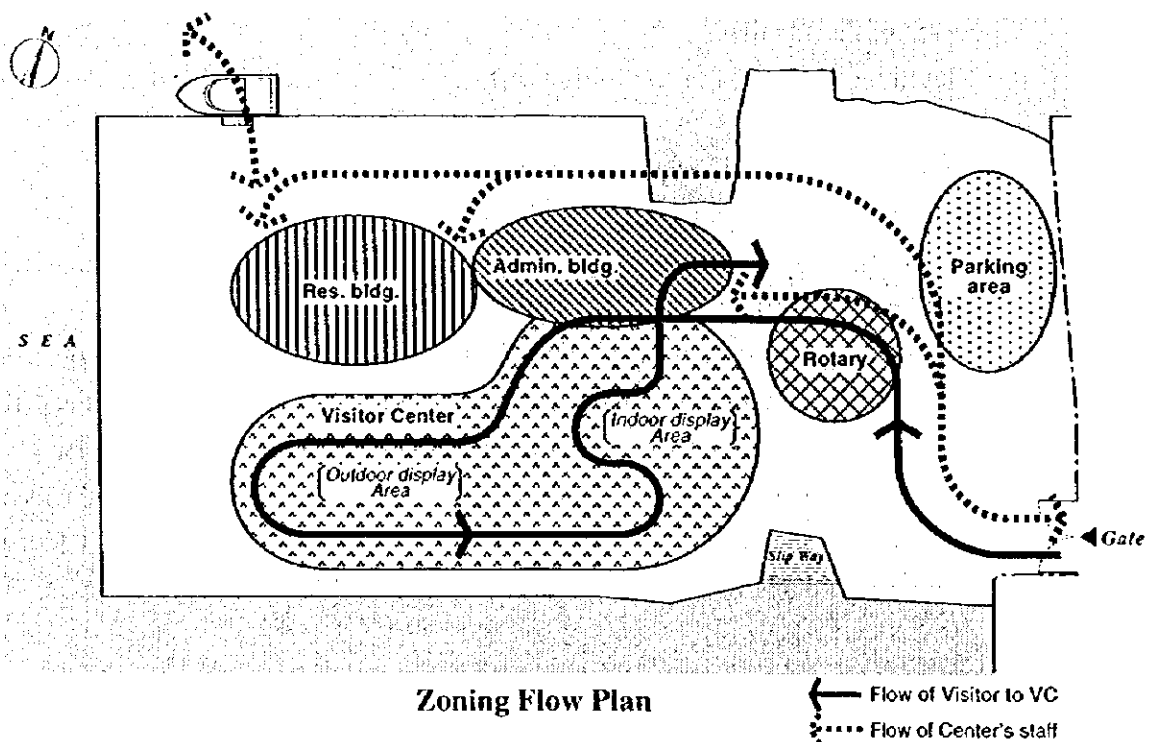
The east end of the site connects to the access road leading out to the main road of Koror town. The area of the existing gate will be the entrance/exit for the main line of movement flow for people and cars. A rotary and parking lot will be created at the east end of the site, and the entrance/exit of the buildings will be placed near the parking lot. In order to fully utilize the scenic beauty of the southwest side, the buildings will be arranged in L-shape to create an open area on the southwest side. This open area will be used for outdoor exhibits. This layout will enable the buildings to avoid the inferior grounds on the northeastern side of the site.

The Visitor Center building will be located in the center of the site on the south side, to secure an easy line of movement for visitors and considering the location of the outdoor exhibit space.

The research building will be located on the northwest side to demarcate clearly the research building from the Visitor Center and considering the location of the wharf.

The administration building will be located at the intersecting junction of the research building and the Visitor Center building and near the entrance/exit of these buildings in order to enable efficient management and operations of the facilities.

Based on the above conditions, zoning flow is planned as follows.



## (2) Building plan

### 1) Floor plan

#### (i) Basic room plan of each building

Based on the design policy, facilities that are attractive and highly accessible to both visitors and researchers will be constructed (refer to the basic design diagrams in page 48-51).

#### ① Research building

The research building will consist of one-storied and two-storied segments. The first floor will contain research facilities and will be closely integrated with the building's outdoor facilities. The second floor will contain accommodation quarters, a conference room, and a library. The living quarters and research space will be clearly demarcated. In addition, all rooms will contain setback windows with canopies to prevent room temperatures from rising due to direct sunlight. The view and ventilation factor will also be taken into consideration.

##### a. Research rooms

A total of three research rooms will be provided on the first floor based on the staff personnel plan. One room will be allocated for the Palauan research staff member and the remaining two will be reserved for use by the scientist-in-resident and visiting researcher. These rooms will be integrated with the field for their effective utilization.

##### b. Dry laboratory

The dry laboratory will be provided adjacent to the research rooms to shorten the line of movement for researchers and thereby enabling the integrated use of both facilities. An area for the assistant researcher will be created in the dry lab.

##### c. Specimen room

The specimen room will be located between the dry laboratory and the field. The planned floor space will accommodate 18 specimen shelves to contain about 1,000 specimens in future.

##### d. Training and experiment room

The training and experiment room will be located on the first floor of the research building as a result of overall layout plan of planned rooms, although this room is used for education and public awareness functions. It can be entered directly from the corridor completely avoiding the main entrance of the research building. It will be used for extracurricular training and experiment classes for local elementary and secondary school students. The capacity of the room will accommodate one classroom of students (25).

e. Accommodation quarters

The accommodation quarters will have access to the view on the south side of the site. A dining area, a kitchen, bedrooms, a bathroom, etc. will be located on the second floor. A minimum of two one-bed rooms and one two-bed room will be created.

f. Library

The library will be located on the second floor and the entrance/exit will be provided near the stairway from the first floor to enable easy access by researchers. A reading area accommodating four visitors will be provided. The floor space allocated for the library will be capable of housing 2,000 books and it can be used as an information reading space as well.

g. Conference room

The floor space of the conference room will be capable of accommodating 20 people. As in the case of the library, its entrance/exit will be provided near the stairway on the second floor to promote easy access to other areas.

h. Storage rooms (1), (2)

The storage room (1) will be located near the wharf in the northwestern area of the site since it will house field survey equipment, maintenance material, etc. The storage room (2) will be located on the second floor and will house maintenance material for accommodation quarters such as linen.

i. Workshop

This room will be used for various repair and workshop activities. It will be located near the storage room (1).

j. Pump room

The pump room will house the sea water intake pump, and other pumps and surrounding equipment. It will be located on the west side nearest to the ocean and the sea water intake site.

k. Rest rooms/shower rooms

Women and men's restrooms and shower rooms will be installed.

② Administration building

The administration building will contain one-storied and two-storied sections and will be located at the intersecting point of the research building and Visitor Center for easy management of these two buildings. The ticket office, the multipurpose room, and the museum shop will be located on the first floor in correlation with the visitor flow of movement. The director room, the administration room and the curator room will be located on the second floor.

a. Director room

The director room will be located in the center of the administration building. The office will accommodate the director and one secretary.

b. Administration room.

The room will be located adjacent to the director room, in view of its function of operation and maintenance of the Center. The room will provide a space to accommodate one financial officer, three cashiers and one clerk.

c. Curator room

The curator will be responsible for educational planning activities as well as exhibits. The curator room will also be located in the administration building in anticipation of frequent discussions with the director and financial officer. The planned floor space will accommodate one curator and one education assistant.

d. Multipurpose room

The multipurpose room will function as a lecture room of the Visitor Center, a class room for local elementary and secondary school students, a meeting place for local residents, a space to conduct special exhibit programs, a place to disseminate various information on Palau to visitors.

e. Museum shop

The museum shop will be located on the first floor of the administration building. Since it will be located at the end of the movement line of visitors, the location will be most convenient for use by visitors.

f. Rest rooms

Women and men's rest rooms will be installed for visitor use.

③ Visitor Center building

The Visitor Center building will be a one-storied building that will be integrated with the outdoor exhibit area located on the southwest side of the site. The building will contain indoor exhibit and maintenance rooms. The maintenance room will be concurrently used as a wet lab for research use. Visitors will enter the building through the north entrance, move through the prologue zone to the outdoor exhibit area encompassing the beautiful scenic beauty of the southwest side, and on to the indoor exhibit area through the southwest entrance. Visitors will view the marine organisms and other exhibits against the background of the surrounding scenery and exits the building on the north side. This exit will be located adjacent to the multipurpose room and museum shop and hence these facilities will be easily accessible to visitors. A movement line of the visitor will be thus being created.



a. Exhibit area

The Visitor Center is the Center's major source of revenue. Based on the concept on exhibits delineated in section 2.2.3 (1) 2) "Public Awareness Activities", attractive exhibits and commentaries are planned for the visitor and information about the natural wonders of the Palauan sea and the importance of coral reef conservation will be disseminated. The outdoor exhibit area, which will utilize the surrounding scenic beauty, will attempt to show the diverse ecosystem of Palau. This outdoor exhibit will be a distinctive feature of the Center.

The indoor exhibition room will partially incorporate outdoor space to ensure the integration of the indoor and outdoor areas. A unique display area showing the Palauan coral reef will thus be created.

b. Maintenance room

The maintenance room will be located behind the display tanks to facilitate their maintenance. Filtration tanks, experimental tanks, and equipment needed for rearing marine organisms in the exhibit will be installed in this room. Its floor area will contain the space needed for maintenance equipment and for carrying out rearing experiments as a wet laboratory for research.

c. Aquarist room

The aquarist room will be located in correlation with the line of movement for research and maintenance activities. Its floor area will accommodate a minimum of two aquarists.

④ Other outdoor facilities

A sink for washing equipment, shower, four FRP rearing tanks to raise marine organisms collected in the field, and two quarantine tanks for the exhibit organisms will be installed in the outdoor area of the research building.

In addition, in order to curtail the cost of installing electricity lines, an electric room will be installed at the middle point between the Center building and the transformer mounted on the pole adjacent to the gate on the outer side.

(ii) Floor area plan of each room

The floor area of each room is shown in the following tables in accordance with the floor area standards explained in section 2.2.6 (1) 2).

### Calculation Standard and Planned Values of Floor Area (1/2)

Name	Standard Value <sup>41</sup>	Planned Value
<b>1. Administration Dept.</b>		
Director room	Unit scale : Director; 18.0 to 25.0 m <sup>2</sup> /person Staff; 4.5 to 7.0 m <sup>2</sup> /person	- 23.1 m <sup>2</sup> Director (1), Admin. Assistant (1) 22.5m <sup>2</sup> (18.0+4.5)~32.0m <sup>2</sup> (25.0+7.0)
Office room	Unit scale :  General manager; 13.0 to 18.0 m <sup>2</sup> /person Manager; 6.5 to 8.5 m <sup>2</sup> /person Clerical employee; 4.5 to 7.0 m <sup>2</sup> /person	- 39.1 m <sup>2</sup> 37.5m <sup>2</sup> (13.0+6.5+4.5x4)~54.5m <sup>2</sup> (18.0+8.5+7.0x4)
Conference room	Unit scale : Middle-size conference room; 1.7-1.9 m <sup>2</sup> /person	- 35.6 m <sup>2</sup> 34.0m <sup>2</sup> (1.7x2.0)~38.0m <sup>2</sup> (1.9x2.0)
Rest Room	-	- 6.8 m <sup>2</sup>
<b>2. Research Dept.</b>		
Research room	Unit scale : 16.0 to 23.5 m <sup>2</sup> /room	- 17.8 m <sup>2</sup> (3 rooms) = 53.4 m <sup>2</sup>
Dry laboratory	According to the layout of planned equipment	- 33.5 m <sup>2</sup> (1 room)
Specimen room	According to the layout of 18 specimen shelves for 1000 specimens	- 39.7 m <sup>2</sup>
Library	According to the layout of book shelves for 2000 books, a desk / chairs for 4 persons	- 33.5 m <sup>2</sup>
Workshop	According to the layout of machine and tools	- 33.5 m <sup>2</sup> (including space for a janitor)
Storage (1) 1F	-	- 24.0 m <sup>2</sup>
Pump room	According to the layout of pumps and other equipment	- 24.0 m <sup>2</sup>
Rest room with shower	For men and women	- 15.7 m <sup>2</sup>
Accommodation	Small bed room Large bed room Lounge Rest room	- 8.9 m <sup>2</sup> (2) = 17.8 m <sup>2</sup> - 17.8 m <sup>2</sup> (1) - 24.0 m <sup>2</sup> - 8.4 m <sup>2</sup>
Storage (2) 2F	-	- 13.8 m <sup>2</sup>
Outdoor rearing tank yard	According to the layout of 4FRP water tanks (2,000 x 1,000 x 800mm)	- 24.0 m <sup>2</sup>

### Calculation Standard and Planned Values of Floor Area (2/2)

Name	Standard Value <sup>&lt;1</sup>	Planned Value
3. Visitors Center Dept. Exhibition hall (incl. maintenance room and aquarist room)	$Sw = V \times Rd \times Rt \times Su$ where, Sw = facility scale V = No. of annual visitors ; 54,000 Rd = Max. daily rate of visitor of V : 1/100 (four season type) Rt = Rotation rate ; 1/6 (Average sojourn time : 30 min./person) Su = Unit occupation area of a visitor : 3.0 m <sup>2</sup> /person	- 301.2 m <sup>2</sup> (incl. maintenance room of 107.9 m <sup>2</sup> , of which 8.8 m <sup>2</sup> is occupied by two aquarists.)
Multipurpose room	Unit scale : - Lecture room; 1.0-1.3 m <sup>2</sup> /person - Visiting ratio to M.R: 0.5-1	- 89.1 m <sup>2</sup> $54,000 \times 1/100 \times 1/60 \times (0.5 \sim 1) \times (1.0 \sim 1.3)$ = 45 ~ 117 m <sup>2</sup>
Museum shop	- Max. no. of visitor at the same time in the Center - (Sojourn time at the Center : 30 min.) $54,000 \times 1/100 \times 1/60 = 90$ persons - Sojourn time at the shop : 10 min. - Visiting ratio to M.R: 0.5~1 - Unit occupation area : 2 m <sup>2</sup> /person	- 48.4 m <sup>2</sup>  $90 \times 10/30 \times (0.5 \sim 1) \times 2 = 30 \sim 60$ m <sup>2</sup>
Storage for museum shop		- 18.6 m <sup>2</sup>
Curator room (incl. space for education assist.)	Unit scale : General manager; 13.5 - 18.0 m <sup>2</sup> Manager; 6.5 - 8.5 m <sup>2</sup>	23.1 m <sup>2</sup> - Curator (1), Education assistant (1) 20.0m <sup>2</sup> (13.5+6.5) - 26.5(18.0+8.5)
Training/Experiment lab.	According to the layout of tables / chairs and sinks for 25 pupils	- 48.1 m <sup>2</sup>
Rest room	According to the layout of following equipment: For ladies - stool x 4 - wash basin x 3 For men - stool x 2 - wash basin x 3 - urinal x 3	- 32.0 m <sup>2</sup>
Outdoor fish holding tank yard for quarantine	3.0 m diameter x 2	- 24.0 m <sup>2</sup>
4. Other Building Electric room	According to the layout of emergency generator and various panels	- 38.0 m <sup>2</sup>

Remarks <1 : Referred from the following documents.

1) "Collection of Information on Architectural Design" published by the Architectural Institute of Japan.

2) " Guide to Formulating a Basic Plan for Provision of Museum Exhibition Facilities (Visitors Center)"

Edited by Environment Agency (Japan).

(iii) Basic furniture plan

Basic and essential furniture to satisfy functions of each room was selected and shown in the following table..

List of Furniture

	Office desk	Table	Chair	Side cabinet	Work table	Sink	Kitchenette	Shelf	Wall rack	Shop rack	Counter	Bed	Baby bed
<b>1. Administration</b>													
Director room	2	.	2	1	.	.	.	1	.	.	.	.	.
Manager room	1	.	1	1	.	.	.	1	.	.	.	.	.
Administration room	4	.	4	.	.	.	.	3	.	.	.	.	.
Conference room	.	8	20	.	.	.	.	.	.	.	.	.	.
Rest room (including utility)	.	.	.	.	.	1	.	.	1	.	.	.	.
<b>2. Research</b>													
Research room (1),(2)	1	.	3	1	1	1	.	2	.	.	.	.	.
Research room (3)	2	.	2	.	.	1	.	2	.	.	.	.	.
Dry laboratory	1	.	1	.	.	1	.	.	.	.	.	.	.
Specimen room	.	.	.	.	.	.	.	2	.	.	.	.	.
Library	.	1	4	.	.	.	.	.	.	.	.	.	.
Workshop	.	1	1	.	.	.	.	.	.	.	.	.	.
Storage (1)	.	.	.	.	.	.	.	1	.	.	.	.	.
Shower/Rest room	.	.	.	.	.	.	.	2	.	.	.	.	.
Pump room	.	.	.	.	.	.	.	.	.	.	.	.	.
Outdoor tank yard	.	.	.	.	.	.	.	.	.	.	.	.	.
Bed room (1)	.	1	1	.	.	.	.	.	.	.	.	2	.
Bed room (2),(3)	.	1	1	.	.	.	.	.	.	.	.	1	.
Dining room	.	1	6	.	.	.	1	.	.	.	.	.	.
Storage (2)	.	.	.	.	.	.	.	1	.	.	.	.	.
Rest room	.	.	.	.	.	1	.	.	.	.	.	.	.
<b>3. Education/Public Awareness</b>													
Curator room	2	.	2	2	.	.	.	2	.	.	.	.	.
Exhibit room	.	.	.	.	.	.	.	.	.	.	.	.	.
Maintenance room	.	.	.	.	1	2	.	.	.	.	.	.	.
Aquarist room	2	.	2	.	.	.	.	.	.	.	.	.	.
Multi-purpose room	1	.	91	.	.	.	.	.	.	.	.	.	.
Ticket office	.	.	1	.	.	.	.	.	.	.	.	.	.
Museum shop	.	.	1	.	.	.	.	.	.	19	1	.	.
Training/experiment room	.	.	.	.	.	.	.	1	.	.	.	.	.
Rest room	1	3	26	.	2	.	.	2	.	.	.	.	.
Quarantine tank yard	.	.	.	.	.	.	.	.	.	.	.	.	1
<b>4. Outdoor facility</b>													
Electric room	.	.	.	.	.	.	.	.	.	.	.	.	.

## 2) Section plan

### ① Determination the bottom level of excavation and level of the first floor

The bottom level of excavation and the level of the first floor will be determined based on the results of the boring test, the level of the access road, sea level, etc.

- Bottom level of excavation

Considering the ground water level, bearing pressure, work period and work efficiency, the bottom level of excavation will be determined at the lowest ground level in the area for planned buildings. In this case, the bottom level of excavation will be higher than the highest sea water level, and relevant excavation works will not be influenced by the tidal fluctuations.

- Level of the first floor

The level of the first floor will be set about 15cm higher than the level of the access road (MSL + 190cm) in order to minimize difference in level and to prevent possible flood damage. Accordingly, the level of the first floor will be 20cm to 60cm higher than the existing ground level.

### ② Section plan of the research and administration buildings

Taking into full consideration the surrounding scenery of the site jutting out to the sea and to utilize the space effectively, the research and administration buildings will be one-storied with two-storied segments and the configuration of the roof will be in the shape of a gently curved arc. The configuration will utilize natural ventilation and allow the outside air to flow into the research building through the first floor corridor to the second floor via the air void and expelled outside.

### ③ Section plan of the Visitor Center building

The Visitor Center building is planned as an area integrated with the outdoor exhibit area and the superb scenic environment. The ventilation blocks which will be used for the exterior building walls and the openings will allow natural ventilation. The openings to be made in the upper part of the exterior wall will allow the warm air in the rooms to be expelled outside. The ceiling height of the maintenance room will be higher than 4m to allow the aquarists to work above the display tanks.

### 3) Structure Plan

#### ① Design seismic velocity

Earthquake seldom occurs in Palau. Palau has been classified as Zone 2A according to the U.S. Uniform Building Code (UBC). The following formulas will be used for the design seismic velocity (V) in accordance with this classification.

$$V = (Z \cdot I \cdot C / R_w) W = 0.076W,$$

where

Z : Seismic zone factor = 0.15 (Zone 2A)

I : Importance factor = 1.00

C : Numerical coefficient =  $1.25S/I^{2/3} = 2.53$

S : Site coefficient for soil characteristics = S1 (stiff or dense soil condition where the soil depth is less than 200 ft) = 1.0

T :  $C_t \cdot hn^{3/4} = 0.35,$

where,

C<sub>t</sub> = Coefficient for structural type = 0.030 (RC structure)

hn = Building height = 8.1 m = 26.6 ft

R<sub>w</sub> : Numerical coefficient for structural system = 5 (OMRF, b)

OMRF, b : Ordinary moment-resisting frames, concrete

W : Building weight

#### ② Design wind load

The design wind load will be calculated based on the UBC. Standard wind force is set at 56m/sec (125mph).

$$P = C_e \cdot C_q \cdot Q_s \cdot I = 254.8 C_q \text{Kgf/m}^2$$

Where

C<sub>e</sub>: Coefficient determined by degree of soil surface coarseness and fineness and building height = 1.30

C<sub>q</sub>: Wind force coefficient (differs according to building portion; main frame 1.30)

Q<sub>s</sub>: Standard wind pressure = 40.1psf = 196kgf/m<sup>2</sup>

I: Importance factor = 1.00

#### ③ Basic structure

In the Project site a dense gravel and boulder fill is distributed from surface to about 4m to 8m depth, with the exception of some loose areas. A long-term bearing pressure of 10t/m<sup>2</sup> is estimated based on the boring test. However, due to the existence of weak sections in the ground site, a highly rigid foundation is needed. As a result, the foundations of the buildings will be constructed of RC mat slab.

④ Upper structure

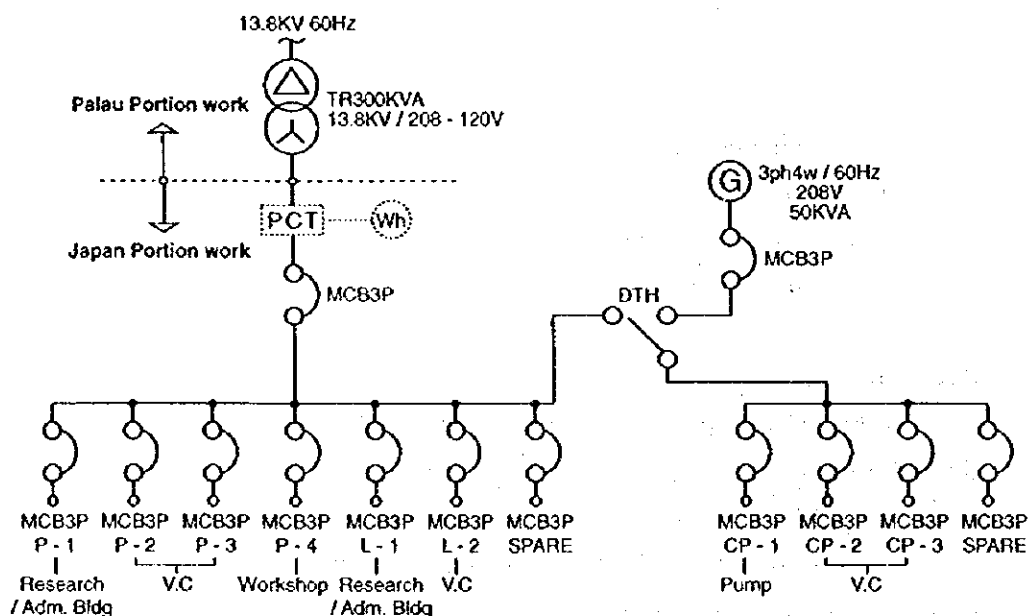
The upper structure of the buildings will be RC rigid-frame structure. The walls will be constructed of concrete blocks, on which rigidity and bearing strength are not counted. The foundation and the upper structure of the administration and Visitor Center buildings will be structurally connected to each other.

4) Facility plan

The facility plan will be based on the three criteria, i.e. easy maintenance and operation, durability against sea air damage and other external conditions, and low maintenance costs. Monitoring, emergency, information and communication facilities, etc. will be concentrated in the administration room, to ensure efficient management of the facilities.

① Power supply/emergency generator

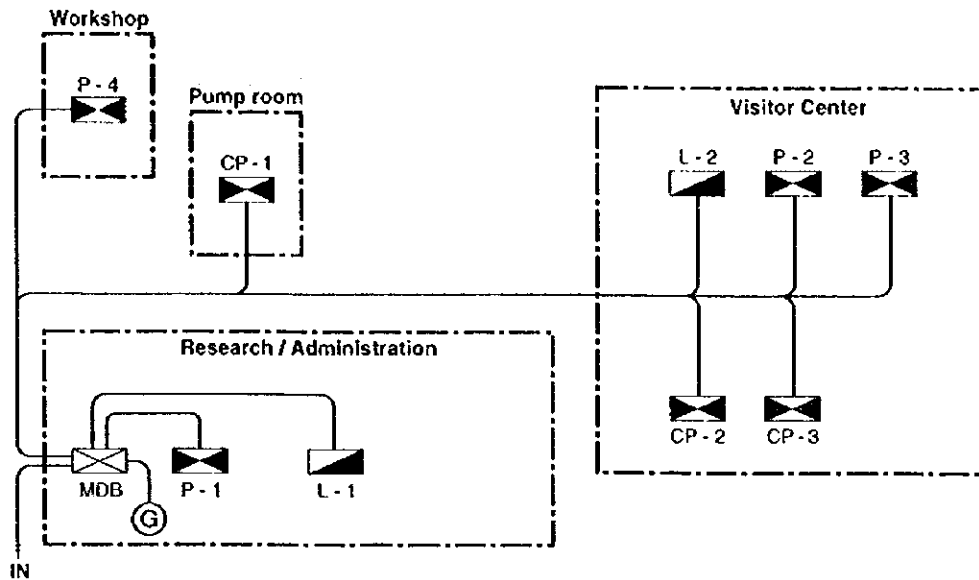
Electricity will be supplied from the pole-mounted transformer adjacent to the Project site, through the underground electricity lines to the electric room. The electricity is supplied to each load via the main distribution panel. An emergency power generator will also be installed to cope with power failures. The emergency electricity capacity will be restricted to a level of 50kVA, limiting its use for machines requiring constant power supply such as the water intake pump, air blower, fire prevention equipment, etc. The electricity specifications in Palau are 208V (3 phase) and 120V (single phase). The electricity single line diagram is shown below.



Electric Single Line Diagram

② Main feeder line

The electricity within the premises will be supplied from the main distribution panel in the electric room to the lighting distribution panel, the power distribution panel, and the control panel. The electricity lines outside the buildings will be installed underground to prevent sea air damage. The main line diagram is shown below.



Main Line Diagram

③ Electric power facilities

The electric power to operate the pumps, ventilation equipment, experiment machinery and instruments, etc. will be supplied by the power distribution panel installed in each location. The electric power facilities and machinery and instruments will be waterproof, durable against sea wind damage. The conduit piping will be a PVC pipe that is also durable against sea air corrosion.

④ Lighting fixtures and outlet facilities

Fluorescent light fixtures will be used mainly. Anti-corrosive and waterproof direct lighting fixtures will be installed outdoors and for the display tanks. Streetlights will also be installed in designated locations. Exclusive circuits will be used in the outlets for experiment machinery and instruments and ventilation equipment. The outlets installed for maintenance room, water tank lighting, and outdoor use will be waterproof types with grounding to prevent electricity leakage and electrocution, and an electric leakage breaker will be installed. In principle, the lines for outlets and lighting will be exposed in the maintenance room, electric room and



workshop, etc. and concealed in other rooms. The conduit piping will be a PVC pipe as in the case of the electric power facilities.

#### ⑤ Information facilities

- Telephone

An electronic phone system will be utilized. The main unit will be installed in the administration room, and the terminal units in the research rooms, the lab, the director room, the administration room, and in other rooms where required. Each terminal phone will have an inter-phone function to enable extension calls to be made or received.

- Public address system

A public address system will be installed within the Visitor Center for announcements to visitors and for emergency broadcasts. The speakers will be installed in designated locations in corridors and in the exhibition area. The main equipment and microphone will be installed in the administration room.

- Wireless equipment

A radio station unit will be installed in the administration room as a means of communication with the survey boat during field surveys and motor vehicles. The frequency band will be VHF, which is commonly used in Palau.

#### ⑥ Emergency equipment

Emergency lighting (emergency exit lights, corridor lights) will be installed at the building's exits, along the corridors, and other designated locations. All emergency lighting will utilize built-in batteries for use during power failures.

Fire alarms (manually operated) and emergency bells will be installed in the corridors and in other designated locations. The indicator panel will be installed in the administration office.

#### ⑦ Monitoring system

A monitoring panel will be installed in the administration room to monitor the operating conditions of the electric facilities, the emergency power generator, the pumps, etc. and to check and warn of breakdowns and other abnormalities.

#### ⑧ Audio guidance system

A set of audio guidance system will be provided for visitors in the exhibit area of the Visitor Center. This system can intensify the exhibit effect to the visitors who can listen to the interpretation of exhibits through earphones when they approach to

the exhibits, panels, etc., and start functioning system. Earphones and portable receivers will be rented to the visitors at the entrance.

⑨ Air conditioning equipment

Air conditioning in the designated rooms of the research and administration buildings will be supplied through a semi-central system with air-cooled condensing units installed outdoor and cooler units. Each cooler unit can be controlled independently and operated only in the room in which cooling is required. The average temperature in Palau is 27.6°C with only a slight fluctuation throughout the year. Hence heating facilities are unnecessary and only cooling facilities will be installed. Air conditioning facilities will not be installed in the Visitor Center building since it will be integrated with the outdoor exhibit area.

A pressurized ventilator will be installed to the power and pump rooms, the workshop, etc. which requires large ventilation volumes. The other areas will mainly rely on natural ventilation, but fans will be installed to provide mechanical ventilation for areas where forced ventilation is required such as the research rooms, dry lab, rest rooms, etc.

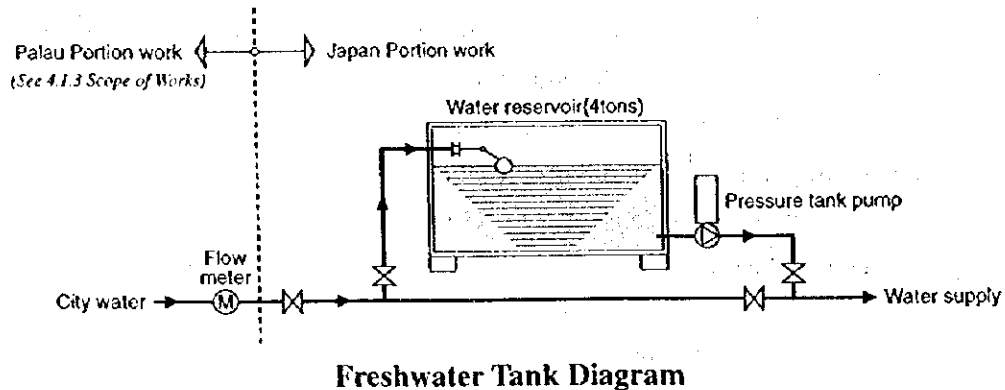
⑩ Water supply, drainage and sanitation facilities

a. Water supply facility

The freshwater at the site will be supplied by the public water service through underground water pipes. Since the required water head pressure is not large because the planned buildings are two stories, the direct connection method utilizing the pressure supplied by the public water service will be adopted. However, an outdoor water reservoir will be installed in the event of suspended water services or water shortage. The reservoir water will be supplied by pressure pump. The maximum daily water supply volume of the Center is estimated at about 4 tons, based on the number of staff members and the anticipated number of visitors to the Visitor Center. Accordingly, the capacity of the water reservoir is calculated based on the following formula.

$$V \text{ (effective capacity of the water reservoir in } m^3 = Q \text{ (daily maximum water volume in } m^3) / t \text{ (amount of time used per day/in hour) } \times T \text{ (potential duration of water supply during water service suspension)}$$
$$V = 4/8 \times 8 = 4 m^3$$

A diagram showing the water supply system using the water reservoir is given below.



b. Drainage facility

Public sewerage has been installed at the site and soil water and other household wastewater will be discharged through the existing drainage pipes. Rainwater will be discharged directly into the sea. Harmful wastes such as drainage from experiments will be collected in a separate plastic tank and disposed.

c. Hot water facility

Hot water will be supplied by a partial supply system with small water heaters in the shower room, utility room, maintenance room, and in other required areas.

d. Fire extinguishers

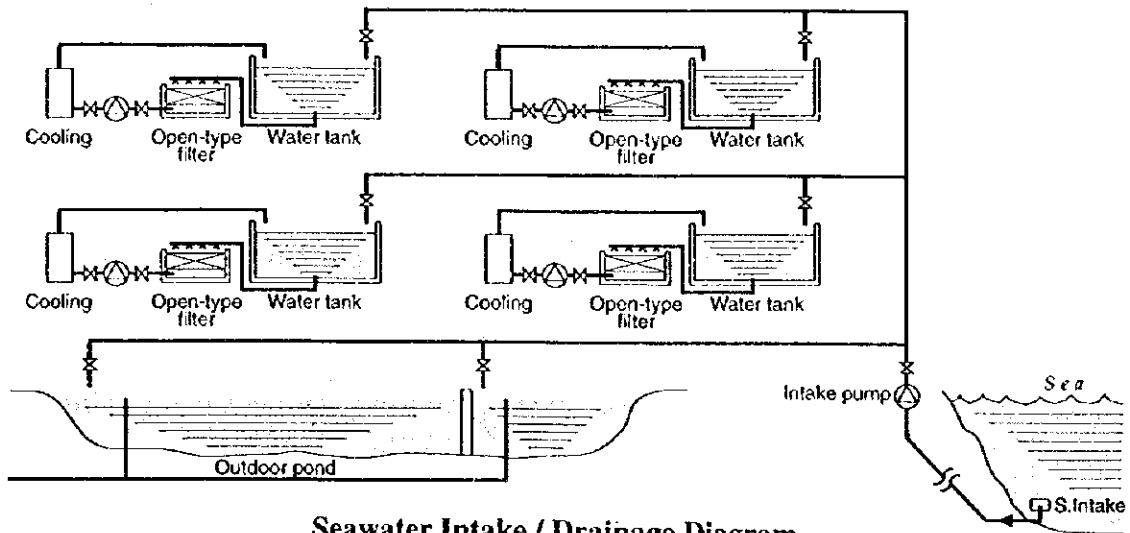
Powder type fire extinguishers will be provided at designated locations in the buildings.

⑩ Special facilities

a. Sea waters intake and supply facilities

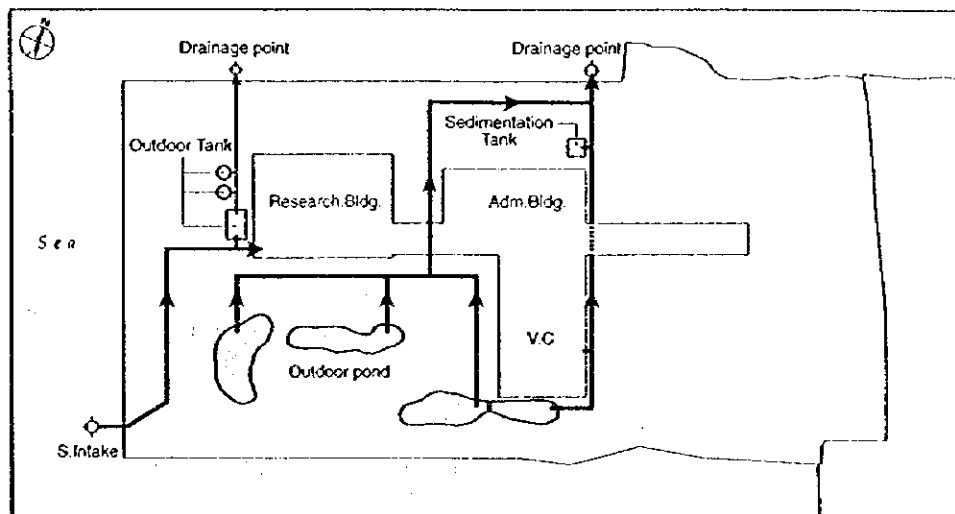
The sea water intake and supply facilities will be installed for the exhibition tanks/ponds and experimental tanks. The intake opening will be located about 5m southwest of the Center site embankment at a depth of about 5m. Seawater will be pumped in through the water intake pipe by a pump installed in the pump room. Sea water thus taken will be used to be divided into two systems, one for the outdoor ponds and the other for the exhibition/experimental tanks, Sea water other than that used in the outdoor ponds will require different levels of temperature in accordance with the requirement of organisms to be reared. Therefore, a closed recalculation

system will be provided for each tank with filter tank and a chilling unit. A diagram illustrating the sea water intake and supply systems is shown below.



**b. Seawater drainage facility**

Seawater from the out-door ponds and exhibition/experimental tanks will be discharged on the north side, in the opposite direction from the sea water intake point in order to lessen the impact on the intake water. In order to avoid the impact of backwash water from the filter tanks on the surrounding sea area, the backwash water will pass through a sedimentation tank (10 tons), and the supernatant water will be discharged and the sludge will be collected. Another drainage will be installed for outdoor ponds since they locate far from the main drainage. A sedimentation tank will not be installed to this drainage since these ponds will be operated by a running water system. The sea water intake and discharge points are shown in the following figure. The estimated SS and BOD of discharged seawater from the Visitor Center are shown in Appendix I.3.



c. Aeration facility

A low-speed route blower will be installed in the maintenance room to provide aeration for the exhibition and experimental tanks. The blower will be installed away from the exhaust of the other machines in the room, in order to maintain air purity levels.

5) Exhibition plan

The following four exhibit themes are planned based on the basic concept delineated in section 2.2.3.

- a. The diverse ecosystems of Palau
- b. Interrelationship between the diverse ecosystems and the culture and lifestyle of the inhabitants
- c. Coral reef science
- d. Importance of conservation

These themes will be integrated and, based on the figure showing the scenario of the exhibits on the following page, a comprehensive exhibition is planned. Particularly, displays for themes a. and b. will not be separated but combined together to demonstrate the close relationship between the nature and the life and culture of the people.

According to the aforementioned policy on exhibits (see 2.3.1(1)), the indoor exhibit create an open and spacious environment utilizing the outdoor air and sunlight, while actively integrating it with the outside exhibit and skillfully incorporating the natural features surrounding the site. The exhibits will be made employing mainly the biotope exhibit and the goal is to create attractive, easy-to-understand, and educational display.

① Introductory part

The exhibits will be located near the entrance of the Visitor Center as an introduction to the Center. In addition to an explanation of the Center's goal, information on how the Palauans have lived in harmony with the rich and diverse ecosystems and the bounty, which they have received from the ecosystems, will be disseminated to visitors through various media.

② Interrelationship between the diverse ecosystems of Palau and the culture and lifestyle of its inhabitants

An explanation will be provided on the structure of the diverse ecosystems of Palau and a biotope exhibit will be created for each habitat. The exhibit will mainly be composed of water tanks and pools in combination with photographs, panels, etc.

③ Coral reef science

The aim is to deepen the understanding on coral reefs through providing information on the ecology/biology of corals and the structures and origin of coral reefs, etc. using water tanks, models, specimens, panels, etc.

④ Coral reef conservation

This presentation will be located near the exit of the Visitor Center. Information will be disseminated on the role of coral reefs in the global environment and the destruction of coral reefs by human development in the world including Palau, through video, panels, photographs, etc. The aim of the exhibit will be to help each visitor reflect on such issues as "what should we do" and "what can we do", the importance of coral reefs, and the relevance of coral reef conservation.

The scenario of the exhibits and the contents and methods of exhibit are shown in the following figure and tables.