

CHAPTER 3 IMPLEMENTATION PLAN

3-1 Implementation Plan

3-1-1 Implementation Concept

When the Project is implemented, the procedures will be as follows. Following the Exchange of Notes between Japan and the Tonga Governments, a Consultant Contract will be signed between a Consultant, a Japanese corporation recommended by JICA, and the Tonga Government. The Consultant will prepare the tender documents required for the Project implementation and carry out the tender phase as proxy for the Tonga Government. After a Construction Contract is concluded between the Tonga Government and the Contractor, the latter organization will undertake construction of the facilities while procuring equipment and materials, with the Consultant supervising the entire construction program. The functions of the various parties with respect to the Project implementation are outlined below:

(1) Implementing Organization

The implementing organization on the Tonga side for the Project will be the Ministry of Fisheries, which will become the Client for the Consultant and Construction Contracts. The counterpart organization for the Project implementation will be the Aquaculture and Research Section of this Ministry. This section will be the liaison point for all procedures involving Tonga authorities and will also be responsible for examining and approving the Project contents. Developmental approvals for laying the intake pipe come under the jurisdiction of the Ministry of Fisheries. Approval has already been received from this Ministry for the cutting of mangrove stands and partial destruction of coral reef areas in connection with the proposed construction activity.

(2) Consultant

The Consultant will carry out detailed design including to prepare drawings, specifications, cost estimates, and other documents for tender, as required for the Project implementation and, as proxy for the Tonga Government, will carry out pre-qualification of bidders, tenders, and tender appraisals, and will recommend the most suitable Contractor to the Tonga Government. To ensure smooth implementation of the work, the Consultant will also provide construction supervision throughout the Project from conclusion of the Construction Contract between the Tonga Government and the Contractor through completion and hand over.

(3) Contractor

The Contractor will be a construction company of Japanese nationals, as selected via open tenders.

Following the conclusion of the Contract with the Tonga Government, the Contractor will construct the plan facilities and procure the necessary equipment and materials, pursuant to the Contract.

As the subject Project will be implemented under a grant aid from Japan, the construction schedule must be strictly adhered to, while all products and facilities must meet prescribed quality standards. The construction phase will be carried out in accordance with the following guidelines, based on construction and social conditions in Tonga as well as natural conditions at the Project site.

- 1) The plan facilities will include marine civil engineering work, such as an intake strainer and pipe, as well as architectural facilities, such as a pump house, a night worker's station and awning. Accordingly, under the construction plan, two technical specialists, in the fields of civil engineering and building construction, respectively, will be dispatched to Tonga and remain there throughout the construction period for civil engineering and around 5.5 months for building construction, to take charge of their areas of expertise.
- 2) The installation of the water intake strainer and the laying of the intake piping will involve underwater operations and, since a high degree of precision will be required to maintain an airtight environment, while the construction will also include piping work that requires relatively high levels of technology in terms of supplying water from the intake point, via the filtration tank, to an elevated tank, a provision will be given to dispatch a technical supervisor to oversee the pipe laying work. In addition, dispatching another electrical specialist will be required to supervise installation and operation of the pumps, generator, and other equipment.
- 3) It is planned to have a local construction company handle labor recruitment and local procurement of construction equipment and materials, as a subcontractor to the Contractor.

3-1-2 Implementation Conditions

- (1) Construction activity must be organized in such manner as to prevent disturbance of operations at the Marine Research Center as possible, so that culture programs can continue unimpeded throughout the construction phase. Particularly in connection with the changeover from the old to new seawater supply system, special care will be taken in planning the work, in close collaboration with the Aquaculture and Research Section, based on an adequate program of test operations for the new facility.
- (2) By the very nature of plan construction, the construction sites will overlap with culture sites, so that culture operations will inevitably encroach on construction operations. Moreover, as certain of the

existing structures are extremely close to the construction sites, while the Project also involves underwater construction activity, it will be incumbent to adopt appropriate safety measures when planning the various construction phases.

- (3) In connection with the seaside marine engineering work, such as laying the intake piping and installing the intake strainer, a supreme effort will be required to minimize impact on the environment, with particular reference to mangrove areas and coral habitats. In particular, since excavated earth and sand are scattered over the vicinity after heavy rainfall, there is a need for proper countermeasures, such as preventive refilling of earth and sand when stormy weather is anticipated.
- (4) The rainy season in the Project site extends from October to April, with ever-present concern over cyclones. Special precautions must be taken in this respect in preparing the construction timetable, particularly with regard to the seaside phases, which are particularly weather-sensitive.
- (5) It is planned to procure materials for the intake pipe, a large excavator, and other major construction materials and equipment from Japan or third countries. Since material shortages or equipment breakdowns could have a grave impact on the construction period, it will be essential to develop a comprehensive program for inventory and quality control of materials, along with equipment maintenance.

3-1-3 Scope of Works

(1) Project Responsibilities to be Assumed by the Government of Japan

- 1) The construction work, including removal of the existing reservoir tank, elevated tanks, and octagonal culture tanks
- 2) Procurement of equipment and materials (including ocean and inland transportation to the construction site)
- 3) Consultant services

(2) Project Responsibilities to be Assumed by the Government of Tonga

- 1) Securing construction sites, land preparation, and necessary landscaping following the Project completion including replant of mangroves
- 2) Partial relocation of culture organisms in connection with the construction program

- 3) Bringing water and power into the Project site, installing the transformer, and assuming responsibility for all related procedures and costs

3-1-4 Consultant Supervision

Following signing of the Construction Contract and pursuant to the Consultant Contract with the Tonga Government, the Consultant will initially approve the construction plans submitted by the Contractor and inspect products in Japan. During the construction period, supervisory personal will be dispatched by the Consultant to Tonga for short periods, in tandem with the main construction phases (construction of the intake pipe, completion of the buildings, and final completion and turnover of all the facilities) to supervise, inspect, direct, and be present during the particular phase of the construction program. In the case of the intake pipe, which is the lifeline of an aquaculture facility, since it will be difficult to validate this item after refill, a civil engineer will be present during the main stages of the pipe-laying work to supervise the construction. On the other hand, as the shore-based facilities for this Project are small in scale, involving no special construction methods, supervision can be provided on a spot basis at the construction stage, by the specialist in charge of buildings and facilities. These technicians will also report progress, as necessary, to concerned agencies of the Tonga government as well as to the Embassy of Japan and the JICA office in Fiji.

3-1-5 Procurement Plan

(1) Principal Materials

Among the construction materials and equipment for this Project, sand, gravel, concrete blocks and certain other locally available items will, in principle, be procured in Tonga. However, items which would be difficult to source domestically, such as piping materials for the intake pipe, steel materials, laminated wood, roofing materials, and equipment for the seawater intake facilities, will be sourced in Japan or third countries. The procurement plan for the main construction materials to be used in this Project is given in Table 3-1.

(2) Principal Items of Construction Equipment

In the course of plan construction, large excavating equipment will be required for burying the intake pipe. In Tonga, a large excavator, fitted with a rock breaker, is owned by the Ministry of Works, but there is no assurance that this equipment will be available when required for this Project. Since burying the intake pipe constitutes a prime phase of the construction program, exerting a major influence on the construction schedule, it has been concluded that the excavator (with rock breaker attached), underwater pumps, and certain other items will have to be sourced in Japan or nearby third countries. All other heavy construction equipment items for general use are available in adequate

numbers in Tonga and so will be procured locally.

Table 3-1 Procurement Plan for the Main Construction Materials and Equipment

| Principal Construction Materials | Procurement Source(s) |
|----------------------------------|-------------------------|
| Sand | Tonga |
| Gravel | Tonga |
| Cement | Tonga |
| Reinforcing bar | Japan |
| Intake piping | Japan |
| Laminated Wood | Japan / third countries |
| Roofing material | Japan / Tonga |
| Other Products | Procurement Source(s) |
| Electrical wire | Japan |
| Lighting fixtures | Japan |
| Switches and sockets | Japan |
| Distribution board | Japan |
| Water supply and drainage pipes | Japan |
| Intake pump | Japan |
| Filtration tanks | Japan |
| Generator | Japan |

(3) Transport Plan

There is regular sea freight service from Japan to Nuku'alofa port, with a sailing time of some 3-4 weeks. The equipment and materials procured from Japan will be shipped via regular freight service, with inland transport used from Nuku'alofa port to the Project site.

3-1-6 Implementation Schedule

The sequence of implementation of the Project will flow as follows : detail design; tender operations ; construction and procurement of materials and equipment. Since the Project site lies in the capital area, it has been established that local procurement conditions for labor and construction equipment and supplies along with infrastructure, in terms of road, power, and water supply, will present no particular problems. However, when considering the implementation stages, as the very nature of this Project dictates scrupulous observance of the construction period, a minute progress plan will be required, giving special consideration to the procurement plan for labor, equipment, and materials as well as natural conditions in the Project site.

In preparing the Project implementation schedule, it has been carefully considered, based on the nature of each phase of the engineering program, which stages must precede the main construction work, which can be undertaken simultaneously or independently. On this basis, it has been

developed an optimum progress plan based on a temporary construction plan, a procurement plan for materials and equipment, construction period, and construction cost.

The principal construction phases and their contents have been classified as follows :

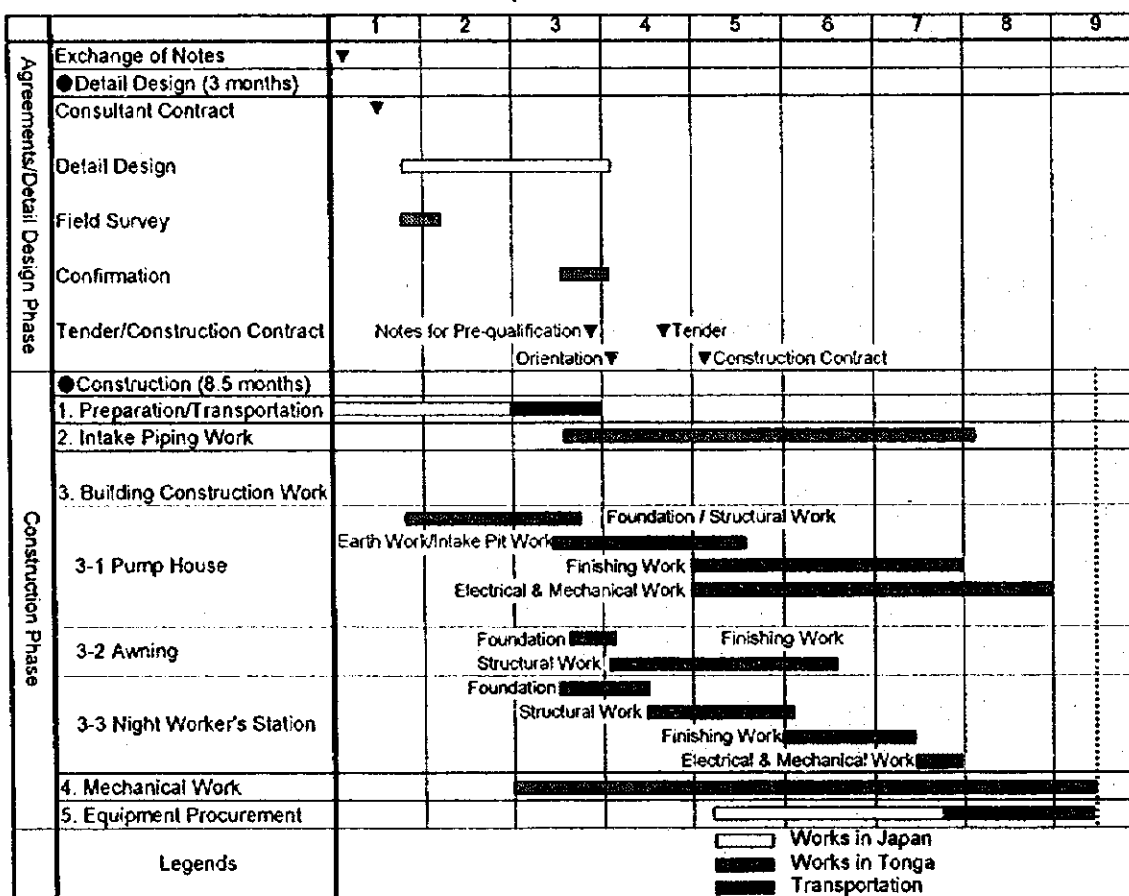
1) Construction Facilities

Construction of the intake pipe, water intake strainer, pump house, night worker's station, awning and settling pond.

2) Electrical and Water / Drainage Facilities

Installation work for the intake pumps, filtration tanks, and the elevated tank; electrical work; piping work; and work relating to mechanical facilities (water supply and drainage).

Table 3-2 Implementation Schedule



The period required for each stage of the Project implementation can be estimated as follows : some 3 months for the implementation design, including tender services; about 4.5 months for the

marine engineering work, including burying the intake pipe and installation of the water intake strainer; and about 8 months for facility construction, electrical work, and sanitary equipment for the water and drainage system. The Implementation Schedule is shown in Table 3-2.

3-1-7 Obligations of Recipient Country

If the subject Project is implemented on the basis of Japan's grant aid, the Tonga government will assume responsibility for the following procedures and costs:

- 1) Obtaining all construction approvals and other necessary permits for the Project implementation, and defraying the costs thereof,
- 2) Arranging customs exemptions and speedy clearance for all materials and equipment imported into Tonga in connection with the Project,
- 3) Exempting Japanese nationals residing in Tonga to provide services for the Project from local taxes and surcharges,
- 4) Banking Arrangement (to establish an account in the name of the Government of Tonga at a bank in Japan),
- 5) Issuing of Authorization to Pay and assuming of related charges for payment, based on the Banking Arrangement with the above bank, and
- 6) All other items required for the Project implementation apart from those assumed by the Government of Japan.

3-2 Project Cost Estimation

The total cost to be borne by Tong side for this Project may be estimated at T\$13,000, with the following breakdown.

| | |
|--|-----------|
| 1. Cost for mangrove transplanting and removing existing obstructs | T\$10,000 |
| 2. Charges for issuing Authorization to Pay | T\$3,000 |
| Total | T\$13,000 |

3-3 Operation and Maintenance Costs

Operation and maintenance of the plan facilities are to be carried out on a sustained basis by the Aquaculture Research Section of the Ministry of Fisheries. In this section, it has been prepared an estimate of maintenance and administrative costs for the plan facilities as a benchmark for the Ministry of Fisheries in developing future budgets for ongoing facility operation. However, inasmuch as the scale of the plan facilities has been determined on the basis of current operating patterns at the Marine Research Center, no staff increases nor changes in operating content are anticipated. Accordingly, since the Ministry of Fisheries will be able to calculate personnel and activity budgets on the assumption that present activity patterns will continue, our calculations have been limited to a consideration of power and maintenance costs associated with the renewal of the seawater intake system.

(1) Power Costs

The only source of increased expenditures as a result of the Project implementation will be power costs associated with the increased capacity of the new facilities. Tentative calculations of operating costs in connection with intake and aeration functions are shown in Table 3-3 below.

Table 3-3 Estimated Power Costs

| | Power Consumption (kW/h) | Capacity (m ³ /min) | Annual Operation Hours* (hrs) | | Annual Power Costs (T\$) | |
|--------------------------------|--------------------------|--------------------------------|--|-------|---|---------------|
| (A) Existing Facilities | | | | | | |
| -Intake Pump | 5.5 | 0.5 | $620\text{m}^3 \div 0.5 \div 60 \times 0.8 \times 365$ | 6,035 | $5.5\text{kW} \times 6,035 \times @0.27$ | 8,962 |
| -Transfer Pump | 3.5 | 0.5 | $620\text{m}^3 \div 0.5 \div 60 \times 0.8 \times 365$ | 6,035 | $3.5\text{kW} \times 6,035 \times @0.27$ | 5,703 |
| -Blower | 0.95 | 2.8 | 24×365 | 8,760 | $0.95\text{kW} \times 8,760 \times @0.27$ | 2,247 |
| Total | | | | | | 16,912 |
| (B) After Renewal | | | | | | |
| -Intake Pump | 7.5 x 2 units | 0.6 x 2 | $1,095\text{m}^3 \div 1.2 \div 60 \times 0.8 \times 365$ | 4,441 | $15\text{kW} \times 4,441 \times @0.27$ | 17,986 |
| -Blower | 1.2 x 3 units | 1.4 x 3 | $24 \times 0.8 \times 365$ | 7,008 | $3.6\text{kW} \times 7,008 \times @0.27$ | 6,812 |
| -Night Station | 2.2 | | $5\text{hrs/day} \times 0.8 \times 365$ | 1,460 | $2.2\text{kW} \times 1,460$ | 3,212 |
| Total | | | | | | 28,010 |
| Increase (B) - (A) | | | | | | 11,098 |

*Since water requirements decrease during spawning, the average rate for pump operations has been calculated at 80%.

(2) Fuel Costs

Diesel fuel consumption by the emergency generator is estimated at 20 liters per hour. However, as fuel costs for generator operations can be expected to be offset by the drop in power costs during

blackouts, diesel fuel costs have been ignored in this analysis.

(3) Maintenance Costs

Maintenance costs will include inspection and cleaning of the intake pipe, intake pit, and elevated tank, as well as filter media replacement and repairs on pumps and the generator.

Underwater operation will be involved in inspecting and cleaning the intake pipe and intake strainer but, since competent divers are already attached to the staff of the Aquaculture Research Section, this work will not have to be contracted outside. The remaining inspection and cleaning operations are essentially manual in nature and so should not generate any significant supplemental costs.

Frequency of filter media replacement in the sand filtration units will differ considerably, depending on water quality, but it has been assumed here a two-year replacement cycle. Based on the use of sifted coral sand as filtering element, which are locally available, filter media replacement cost has been estimated at T\$100 / m³.

Repair costs for the pumps and blowers will comprise the purchase of spare parts and outside contracting of repair work. It has been set an allowance of about 1% of equipment value for this purpose.

Finally, it has been allowed T\$1,000 per year for the purchase of fluorescent tubes and other expendables, together with paint costs in connection with building maintenance.

Based on the above analysis, the estimated total of operating and maintenance costs anticipated from the Project implementation will run in the order of T\$32,000 per annum. These calculations are summarized in Table 3-4.

Table 2-4 Estimated Maintenance Costs Resulting from Project Implementation

| Cost Category | Breakdown | Annual Maintenance Costs (T\$) |
|----------------------------|--|--------------------------------|
| Power | (as shown above) | 28,010 |
| Filter element replacement | 1.5m ³ x @100 x 2 units ÷ 2 years | 150 |
| Equipment maintenance | 320,000 x 1% | 3,200 |
| Other | | 1,000 |
| Total | | 32,360 |

The ordinary budget of the Ministry of Fisheries in fiscal 1997/98 was T\$893,811, of which maintenance and operations consumed T\$78,898 and purchase of goods and services T\$194,273. By implementing the Project, it is expected to generate an extra T\$32,000 per year of maintenance costs. However, with an offset of perhaps T\$17,000 from operation of the existing pumps, the net increase in

costs from implementing this Project should come to only T\$15,000, which would be equivalent to 19% of overall maintenance expenditures at the Ministry during 1997/98. Accordingly, an additional budget appropriate would be necessary to cover this marginal increase from the Project implementation. The share of the current annual budget allocated for maintenance purposes is tentatively calculated at 3.6%. But, considering the fact that, in recent years, recurrent budget at the Ministry of Fisheries have been rising at an annual rate of more than 10%, it is believed that the Tonga government will encounter no problems in meeting incremental costs arising from the Project implementation.

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

4-1 Project Effect

The Marine Research Center is an indispensable facility for aquaculture development in Tonga, yet is beset by a host of problems, such as superannuated intake and drainage facilities, unsuitable water quality for culture purposes, and inadequate water supply, which have raised grave concerns over the future viability of research and operations. The Project has been developed to invigorate research activities at this Center by renovating the seawater supply system, thereby contributing to the development of Tonga's aquaculture industry. The following effects can be anticipated from the Project implementation.

(1) Improvement in Water Quality and Supply Capacity

The existing intake point has been installed in the moat, making it highly susceptible to externally-induced changes in water quality. In addition to a superannuated seawater supply system of inadequate capacity, the requisite supply of high-quality sea water suitable for culture operations cannot be obtained. And such factors as a drop in salinity and pump breakdowns can cause high mortality rates and inferior rearing. Other problems hindering operations are the complexity of operations to remove silt, which is taken in together with the intake water, as well as the difficulty of maintaining continuous culture operations, owing to the large number of eggs contained in seawater during the coral spawning season.

Based on water intake from the reef edge facing the offshore, stable water temperature and salinity can be maintained, making it possible to obtain seawater that is unaffected by sewage. At the same time, the improvement in intake efficiency will make it possible to maintain a water exchange rate suitable to the scale and nature of the existing rearing facilities. In addition, thanks to the installation of a rapid filtration system, organisms and substances interfering with the rearing process, such as harmful organisms, plankton, and silt, will be removed, while the new awning over the rearing area will terminate rust fall from the superannuated structural members to the grow-up tanks below. Thus, the requisite volume of good-quality rearing water can be obtained, thereby eliminating a critical problem at the Center.

By virtue of these improvements in water quality and intake volume, there will be an end to the accidents suffered by the culture organisms traceable to a decline in salinity, making possible improved survival and growth ratios as well as a stable supply of healthy seeds. They would, moreover, help to prevent damage based on an admixture of harmful organisms and suspended particles, thus alleviating

the burden of removal operations. It has been determined that the collective effect of the improvements can be expected to greatly invigorate research activity at the Center.

(2) Reducing Environmental Impact

At present, drainage from the mariculture facility is discharged untreated into the moat in front of the facilities. In the case of molluscs, which is the focus of Center activity, the environmental impact of this waste solids, even under existing conditions, is considered to be relatively light, but, as a model aquaculture facility in the South Pacific region, the Center must give careful consideration to environmental protection.

Based on the installation of the settling pond, since the waste solids contained in the drainage can, to some extent, be removed without incurring additional operating costs, it can be certainly anticipated a reduction in the environmental load. And, in the future, when introduction trials are conducted with exotic species, utilization of the settling pond will also serve to prevent deviation of such species from the facility. In this sense, based on an inherent compatibility between aquaculture development and environmental preservation, it is considerable significance in including the settling pond in the Project.

(3) Strengthening the Ability to Cope with Emergencies and Security

At an aquaculture facility, it is desirable that a round-the-clock surveillance system be set up to respond to pump breakdowns and other sudden accidents, but, in the absence of night quarters at the Center, it has been difficult to establish such a system at night or on non-working days. This has been one reason for the inability to prevent fatal accidents to the target species.

Based on the provision of a night worker's station, a set-up for nightly shifts as well as daytime duty on weekends and holidays can readily be established, thereby enhancing response capability in emergencies. Also, since the facility will involve a security function, it should be effective in preventing the theft of culture species, particularly large-size giant clams of high commercial value. In addition, during spawning seasons, the facility is to be used as a standby and rest area for night-time operations, thus greatly improving the working environment.

(4) Indirect Effects

As the core facility for aquaculture research, the Center can be expected to advance research and development on the basic technology required to nurture this industry in Tonga. As culture and rearing technology for giant clams and other usable species is diffused throughout the country, based

on applications of these research findings, tourists can be encouraged to visit village ocean nurseries, and their purchases of local aquaculture products would, in turn, generate employment opportunities and new sources of cash income for Tonga's fishermen, including those on outer islands. And by contributing to resource conservation and recovery through seedling release as well as foreign exchange earnings from exports of the cultured products, balanced fishery development will be achieved, based on a fundamental compatibility between environmental protection and economic development. In this sense, the Project can be expected to contribute importantly to the development of the aquaculture industry in Tonga as a base for aquaculture activity throughout the South Pacific regions.

4-2 Recommendation

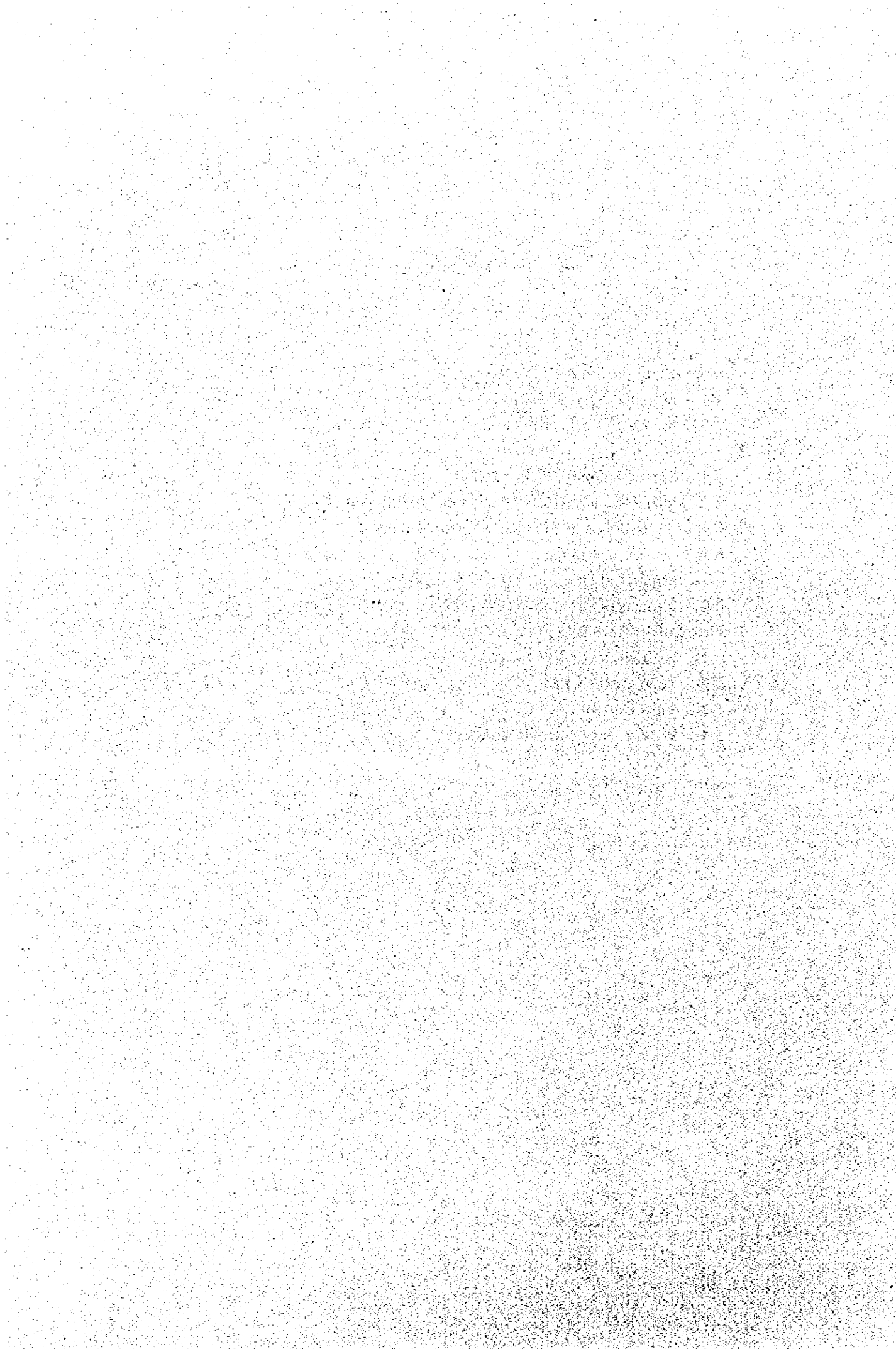
In addition to the multiple effects, as discussed above, that can be anticipated from the Project implementation, since the strengthening of research activity will contribute importantly to aquaculture development and conservation of marine resources, it has been determined that there is considerable significance in implementing this Project under a grant aid. In order to carry out this Project smoothly and efficiently, the following recommendations with respect to certain problems that must be overcome would like to be made.

- (1) Based on the Project implementation, it is expected that annual operating and maintenance costs will increase by about T\$ 15,000 per annum. It will, therefore, be necessary for the Ministry of Fisheries to make definitive budgetary provisions for this additional sum in order to ensure proper ongoing operations.
- (2) Generally speaking, seed production involves a combination of 4 quality elements: water, spawner, bait, and rearing management. If there is a problem in any one of these areas, production will be reduced. For example, even if the problem of water quality is solved, this alone will not guarantee production. Thus, in order to ensure productivity, meticulous consideration must be given to culture management on a daily basis. It is, therefore, essential that the facility strive to improve technological standards at the culture level in the years ahead.
- (3) There is an ever-present danger of large-scale mortality arising from sudden equipment breakdowns. There is, therefore, a pressing need to establish an effective operating structure, including the training and recruitment of maintenance personnel for pumps and electrical facilities, along with a work schedule to cope with emergencies on weekends and holidays as well as during long vacation periods.

(4) Molluscs is the main target species at the Center. While the environmental impact of this drainage is seen as relatively small, careful attention must be paid to environmental protection, as befits a model aquaculture facility in the South Pacific region. The plan settling pond will entail a simple structure with capabilities confined to overflow drainage via settling and filtration of the drainage from the pond bottom through a gravel layer. However, by partitioning the pond by using center supports and incorporating screens and filter materials, more effective drainage treatment can be achieved if it is required in future. In addition, when conducting experimental culture programs based on the introduction of exotic species, by employing the same treatment method, the pond can also help to prevent deviation of cultured organisms from the facilities. In this manner, through effective pond utilization, via remodeling and or other means, as the situation requires, it is hoped that even more meticulous consideration will be given to environmental preservation.

APPENDICES

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1. Member List of the Survey Team

1-1 Member List (Field Survey)

| Function | Name | Organization |
|--|-------------------|---|
| Leader | TODA Atsuyoshi | Development Specialist, Japan International Cooperation Agency |
| Technical Advisor | OKAZAKI Akio | Deputy Director, Fish Ranching and Aquaculture Division, Resources Development Department, Fisheries Agency |
| Coordinator | MORITA Takahiro | Second Project Study Division, Grant Aid Study Department, Japan International Cooperation Agency |
| Chief Consultant cum Fishery Facility Planner cum Natural Condition Surveyor | OGASAWARA Toshiya | Fisheries Engineering Co., Ltd. |
| Facility Engineer | MATSUDA Osamu | Fisheries Engineering Co., Ltd. |
| Construction Planner cum Cost Estimator | TORII Michio | Fisheries Engineering Co., Ltd. |

1-2 Member List (Consultation on Draft Report)

| Function | Name | Organization |
|--|-------------------|---|
| Leader | TODA Atsuyoshi | Development Specialist, Japan International Cooperation Agency |
| Technical Advisor | OKAZAKI Akio | Deputy Director, Fish Ranching and Aquaculture Division, Resources Development Department, Fisheries Agency |
| Chief Consultant cum Fishery Facility Planner cum Natural Condition Surveyor | OGASAWARA Toshiya | Fisheries Engineering Co., Ltd. |

2. Survey Itinerary

2-1 Survey Itinerary (Field Survey)

| Day | Date | | Activities | | | |
|-----|----------|-----|--|--|--|-------------------------|
| | | | Government Officials | | Consultant | |
| | | | Mr. Toda | Mr. Okazaki / Mr. Morita | Mr. Ogasawara | Mr. Matsuda / Mr. Torii |
| 1 | Sept. 24 | (T) | | Lv Narita (FJ303)→ | | |
| 2 | 25 | (F) | | Ar Nadi / Lv Nadi (PC136)→Ar Suva Courtesy call on Embassy of Japan and JICA Fiji Office | | |
| 3 | 26 | (S) | | Lv Suva (PC163)→Ar Nadi / Lv Nadi (FJ211)→Ar Nuku'alofa | | Lv Narita (NZ034) → |
| 4 | 27 | (S) | Lv Guam→ | Team discussion | Ar Auckland | |
| 5 | 28 | (M) | → | Visit to Min. of Foreign Affairs and Min. of Fisheries (MOF) : Explanation on Inception Report, Visit to JOCV Office | Lv Auckland (NZ302)→ Ar Nuku'alofa | |
| 6 | 29 | (T) | Lv Honolulu→ via Auckland→ Ar Nuku'alofa | Site reconnaissance on reef crest and moat areas, Discussion with JICA experts | | |
| 7 | 30 | (W) | Survey for aquaculture facilities, Meeting with Aquaculture Research Section | | | |
| 8 | Oct. 1 | (T) | Discussion meeting with MOF, Survey of existing intake system | | | |
| 9 | 2 | (F) | Drafting of Minutes of Discussion, Signing of Minutes of Discussion | | | |
| 10 | 3 | (S) | Lv Nuku'alofa (WR403)→Ar Nadi | Site reconnaissance | | |
| 11 | 4 | (S) | Discussion within the team members | Information and data analysis | | |
| 12 | 5 | (M) | Lv Nadi (PC162)→Ar Suva | Discussion within the team members | | |
| 13 | 6 | (T) | Report to Embassy of Japan and JICA, Lv Suva (PC163)→Ar Nadi | Topographic survey, Survey for the existing situation of Center facilities | | |
| 14 | 7 | (W) | Lv Nadi (FJ413)→Ar Brisbane Lv Nadi (FJ413)→Ar Auckland (Morita) | Topographic survey, Sampling and measuring of seawater | | |
| 15 | 8 | (T) | Lv Brisbane (JL762)→Ar Narita Lv Auckland (NZ033)→Ar Narita (Morita) | Current observation, Diving survey for sea bottom, Topographic Survey | | |
| 16 | 9 | (F) | | Current observation, Diving survey for sea bottom | | |
| 17 | 10 | (S) | | Measuring of seawater | | |
| 18 | 11 | (S) | | Information and data analysis | | |
| 19 | 12 | (M) | | Discussion within the team members | | |
| 20 | 13 | (T) | | Hydrographic survey, Intake pit survey | | |
| 21 | 14 | (W) | | Hydrographic survey, Materials survey | | |
| 22 | 15 | (T) | | Discussion with Aquaculture Division | | |
| 23 | 16 | (F) | | Seawater sampling, Report to JOCV | | |
| 24 | 17 | (S) | | Interim report to Aquaculture Div. | Lv Nuku'alofa (NZ301)→Ar Auckland | |
| 25 | 18 | (S) | | Collection of supple- mental information | Lv Auckland (NZ099)→Ar Narita | |
| 26 | 19 | (M) | | Data analysis | | |
| 27 | 20 | (T) | | Lv Nuku'alofa (FJ210)→Ar Nadi | | |
| 28 | 21 | (W) | | Lv Nadi (PC136)→ Ar Suva, Report to Embassy of Japan and JICA | | |
| 29 | 22 | (T) | | Lv Suva (PC177)→ Ar Nadi | | |
| | | | | Lv Nadi (FJ302)→ Ar Narita | | |

2-2 Survey Itinerary (Consultation on Draft Report)

| Day | Date | | Activities | |
|-----|--------|-----|---|-------------------------------------|
| | | | Government Officials Mr. Toda / Mr. Okazaki | Consultant Mr. Ogasawara |
| 1 | Dec. 7 | (M) | Lv Narita (JL072) → Ar Honolulu | Lv Narita (FJ303) → Ar Nadi |
| 2 | 8 | (T) | Lv Honolulu (NZ057) → via Apia → | Lv Nadi (FJ211) → Ar Nuku'alofa |
| 3 | 9 | (W) | Ar Nuku'alofa Courtesy call on Min. of Foreign Affairs, Min. of Fisheries and JOCV : Explanation and discussion on Draft Basic Design Report | |
| 4 | 10 | (T) | Joint meeting with Min. of Foreign Affairs, Min. of Finance, Dept. of Central Planning, Min. of Lands, Survey & Natural Resources and Min. of Fisheries | |
| 5 | 11 | (F) | Drafting of Minutes of Discussions, Signing of Minutes of Discussions | |
| 6 | 12 | (S) | Lv Nuku'alofa (FJ210) → Ar Nadi | Lv Nuku'alofa (FJ210) → Ar Auckland |
| 7 | 13 | (S) | Lv Nadi → Ar Suva | Lv Auckland (NZ033) → Ar Narita |
| 8 | 14 | (M) | Report to Embassy of Japan and JICA Lv Suva (PC151) → Ar Nadi | |
| 9 | 15 | (T) | Lv Nadi (QF392) → Ar Sydney | |
| 10 | 16 | (W) | Lv Sydney (JL772) → Ar Narita | |

3. List of Party Concerned in the Recipient Country

3-1 List of Party Concerned in the Recipient Country (Field Survey)

| Name | Title / Organization |
|-------------------------|--|
| Hon. 'Akau'ola | Secretary for Fisheries, Ministry of Fisheries (MOF) |
| Mr. Mafi 'Akau'ola | Deputy Secretary for Fisheries, MOF |
| Mr. 'Ulunga Fa'anunu | Principal Fisheries Officer, Aquaculture Research, MOF |
| Mr. Tevita Finau Latu | Senior Fisheries Officer, Aquaculture Research, MOF |
| Mr. Naita Manu | Technical Officer I, Aquaculture Research, MOF |
| Mr. Poasi Fale | Technical Officer II, Aquaculture Research, MOF |
| Mr. Tupou Tu'avao | Fisheries Technician, Aquaculture Research, MOF |
| Mr. Feauini Vi | Fisheries Assistant, Aquaculture Research, MOF |
| Mr. 'Ofa Paongo | Fisheries Assistant, Aquaculture Research, MOF |
| Mr. Tala'ofa Loto'aohea | Fisheries Assistant, Aquaculture Research, MOF |
| Mr. Kenichi Kikutani | JICA Expert, Aquaculture Research, MOF |
| Mr. Shigeaki Sone | JICA Expert, Aquaculture Research, MOF |

3-2 List of Party Concerned in the Recipient Country (Consultation on Draft Report)

| Name | Title / Organization |
|----------------------------|--|
| Miss Lusitania Latu | Economist, Central Planning Department |
| Mrs. Balwyn Fa'otusia | Principal Economist, Central Planning Department |
| Mrs. Marieta Tukuafu | Principal Economist, Ministry of Finance |
| Mr. Tevita Kolokihakaufisi | Principal Assistant Secretary, Ministry of Foreign Affairs |
| Mr. Asipeli Palaki | Marine Biologist, Ministry of Land, Survey and Natural Resources |
| Hon. 'Akau'ola | Secretary for Fisheries, Ministry of Fisheries (MOF) |
| Mr. Mafi 'Akau'ola | Deputy Secretary for Fisheries, MOF |
| Mr. 'Ulunga Fa' anunu | Principal Fisheries Officer, MOF |
| Mr. Poasi Fale | Technical Officer (Aquaculture), MOF |

4. Minutes of Discussion **MINUTES OF DISCUSSION**

**BASIC DESIGN STUDY ON
THE PROJECT FOR
RENOVATION OF SEAWATER SUPPLY SYSTEM
IN THE KINGDOM OF TONGA**

4-1 Minutes of Discussion (Field Survey)

In response to the request from the Government of the Kingdom of Tonga, the Government of Japan has decided to conduct a basic design study on the project for renovation of seawater supply system (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA has sent to the Kingdom of Tonga a basic design study team (hereinafter referred to as "the Team"), which is headed by Mr. Atsuyoshi TODA, Development Specialist, Japan International Cooperation Agency. The Team is scheduled to stay in the country from 26 September through 19 October 1998.

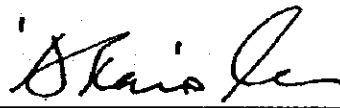
The Team held a series of discussions with the officials concerned of the Government of the Kingdom of Tonga and conducted a field survey at the study area.

In course of the discussions and field survey, both parties have confirmed the main items described on the attached. The Team will proceed to further works and prepare a draft Basic Design Study report.

Nuku'alofa, 2 October 1998



Atsuyoshi TODA
Leader
Basic Design Study Team
JICA



'AKAU'OLA, cvo
Secretary
Ministry of Fisheries

ATTACHMENT

1. Current Problems

The Tonga side identified the problems including low salinity, high temperature and too much silt. The Team fully acknowledged them.

2. Project Objective

The objective of the Project is to supply appropriate quality and sufficient volume of seawater to the Fisheries Research Center by means of renovating the seawater supply system .

3. System Components

(1) Both sides confirmed the components requested by the Government of the kingdom of Tonga as follows:

1. Extend the inlet water supply to the open sea
2. Renew and enlarge the water pit and piping
3. Renew the elevated and reserve tanks
4. Improve the drainage system

(2) Both agreed that each component should not be considered in isolation but be considered as part of a system. The task of the Study should be to design such a system to meet the present as well as immediate future water demand of the Center.

(3) The team has temporarily broken down the system into the following components for an analytical purpose: intake pipe, intake pit, filtering system, elevated tank, reserve tank, distribution pipe, drainage system, pump/blower, electric generator, electric wiring system, roof (cover), room for night workers/emergency case, and pump house. However, what to be included as project components will be finally identified as output of the Study.

(4) The Tonga side mentioned the problem of water contamination from the ceiling of both the wet lab and green houses and the pipelines, especially of the wet lab. The Team acknowledged the problem.

4. Appraisal of the Existing System

Based on quick on-site survey, the Team presented to the Tonga side their first impressions on the existing system. According to them, the present condition of the system may call for its major renovation.

5. Creation and Evaluation of Alternatives

The Team explained to the Tonga side about the future decision-making process of the Japanese side. The Team has been asked for the creation of alternative schemes (e.g. alternative water intake points). Subsequently, these alternatives will be assessed with the criteria of cost/performance, easiness of operation/maintenance, and environmental impact.



6. Executing Agency

The Ministry of Fisheries is both the responsible and the implementing agency.

7. Project Site

The Project site is located in Nuku'alofa, the Kingdom of Tonga.

(The Project area and site map are attached as ANNEX- I .)

8. Further Schedule of the Study

- 1) The consultants will proceed to further studies in the Kingdom of Tonga until 19 October 1998.

- 2) On the basis of the Minutes of Discussions and the technical examination of study results, JICA will prepare a draft Basic Design report and dispatch a team to the Kingdom of Tonga around December 1998 in order to present the contents of the report.

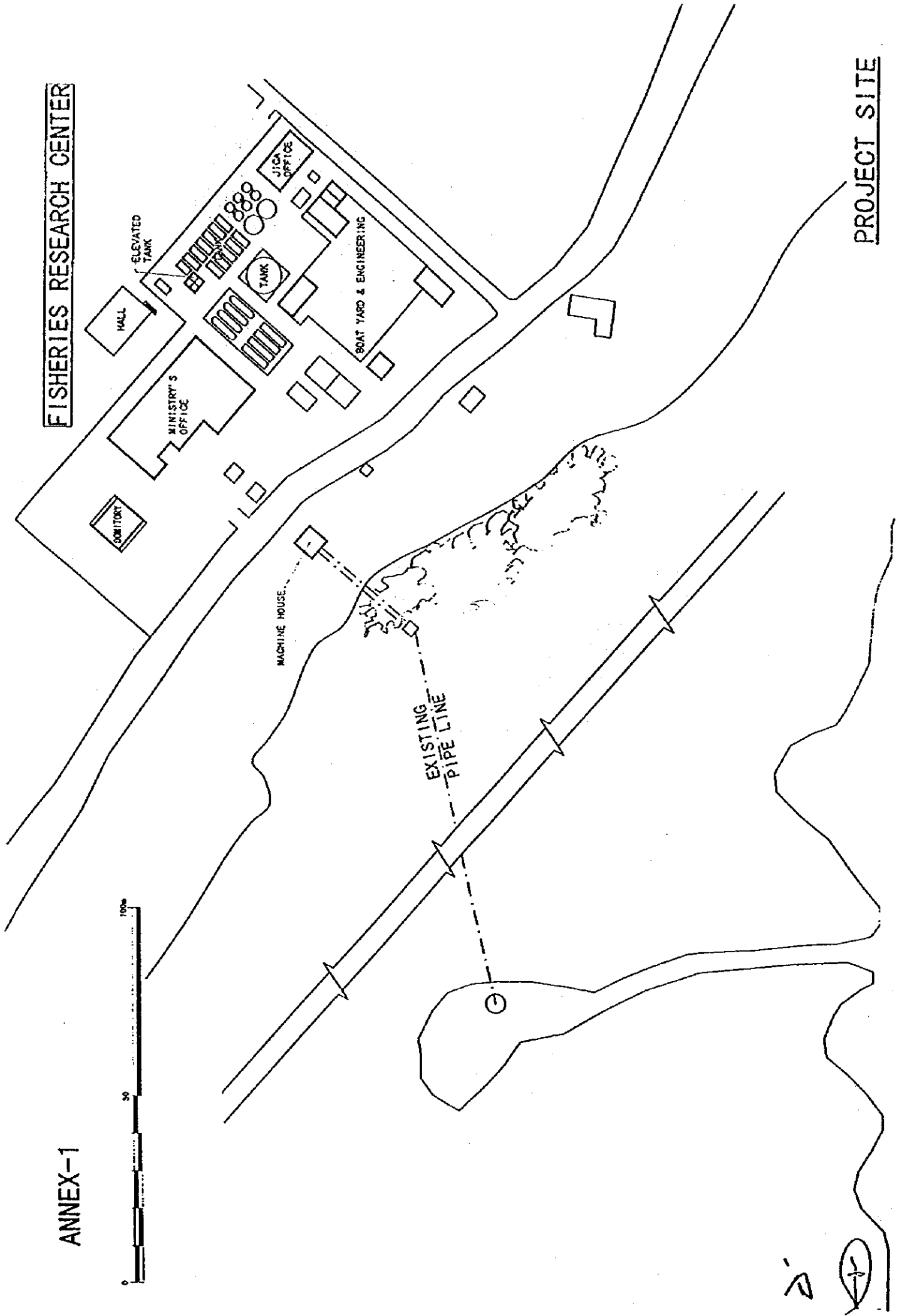
9. Japan's Grant Aid System

- 1) The Government of the Kingdom of Tonga has an understanding of the system of the Japan's Grant Aid, of which main features are described in ANNEX II.
- 2) Should the Grant Aid by the Government of Japan be extended to the Project, the Government of the Kingdom of Tonga will take the necessary measures described in ANNEX III for the smooth implementation of the Project.

1/2 (P)

ANNEX-1

FISHERIES RESEARCH CENTER



PROJECT SITE

ANNEX II: JAPAN'S GRANT AID SCHEME

1. Grant Aid Procedure

- 1) Japan's Grant Aid Program is executed through the following procedures.

| | |
|---------------------------------|--|
| Application | (Request made by a recipient country) |
| Study | (Basic Design Study conducted by JICA) |
| Appraisal & Approval | (Appraisal by the Government of Japan & Approval by Cabinet) |
| Determination of Implementation | (The Notes exchanged between the Governments of Japan and the recipient country) |

- 2) Firstly, the application or request for a Grant Aid Program submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using Japanese consulting firms.

Thirdly, the Government of Japan appraises the program to see whether or not it is suitable for Japan's Grant Aid Program, based on the Basic Design Study report prepared by JICA and the results are then submitted to the Cabinet for approval.

Fourth, the program, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Government of Japan and the recipient country.

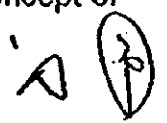
Finally, for the implementation of the program, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Basic Design Study

- 1) Contents of the Study

The aim of the Basic Design Study (hereinafter referred to as "the Study"), conducted by JICA on the requested project (hereinafter referred to as "the Project"), is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

- a) confirmation of the background, objectives and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation;
- b) evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from the technical, social and economic points of view;
- c) confirmation of items agreed on by both parties concerning the basic concept of the Project;



- d) preparation of a basic design of the Project; and
- e) estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid Program. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For the smooth implementation of the Study, JICA uses a consulting firm selected through its own procedure (competitive proposal). The selected firm participates the Study and prepares a report based upon the terms of reference set by JICA.

At the beginning of implementation after the Exchange of Notes, for the services of the Detailed Design and Construction Supervision of the Project, JICA recommends the same consulting firm which participated in the Study to the recipient country, in order to maintain the technical consistency between the Basic Design and Detailed Design.

3. Japan's Grant Aid Scheme

1) What is Grant Aid?

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

2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

3) "The period of the Grant" means the one fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedure such as exchanging of the Notes, concluding contracts with consulting firms and contractors and final payment to them must be completed.

However, in case of delays in delivery, installation or construction due to unforeseen

11

factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

- 4) Under the Grant, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However, the prime contractors, namely consulting, contracting and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

- 5) Necessity of "Verification"

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

- 6) Undertakings required to the Government of the recipient country

- a) to secure a lot of land necessary for the construction of the Project and to clear the site;
- b) to provide facilities for distribution of electricity, water supply, drainage and other incidental facilities outside the site;
- c) to ensure prompt unloading, tax exemption and customs clearance at ports of disembarkation in the recipient country and internal transportation therein of the products purchased under the Grant Aid.
- d) to exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts.
- e) to accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contracts such as facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.
- f) to ensure that the facilities constructed and products purchased under the Grant Aid be maintained and used properly and effectively for the Project; and
- g) to bear all the expenses, other than those covered by the Grant Aid, necessary for the Project.

- 7) "Proper Use"

The recipient country is required to maintain and use the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign the necessary staff for operation and maintenance of them as well as to bear all the

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expenses other than those covered by the Grant Aid.

8) "Re-export"

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

9) Banking Arrangement (B/A)

- a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the verified contracts.
- b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an authorization to pay issued by the Government of recipient country or its designated authority.

2 (3)

ANNEX III: NECESSARY MEASURES TO BE TAKEN BY THE GOVERNMENT OF THE KINGDOM OF TONGA

The following necessary measures should be taken by the Government of the Kingdom of Tonga on condition that the Grant Aid by the Government of Japan is extended to the Project.

1. to secure a lot of land necessary for the Project;
2. to clear and level the site for the Project prior to the commencement of the construction;
3. to provide a proper access road to the site;
4. to provide facilities for distribution of electricity, water supply, telephone trunk line, drainage and other incidental facilities outside the site;
5. to undertake incidental outdoor works, such as gardening, fencing, exterior lightning, and other incidental facilities in and around the site, if necessary;
6. to ensure prompt unloading and customs clearance of the products purchased under the Japan's Grant Aid at ports of disembarkation in the Kingdom of Tonga;
7. to exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the Kingdom of Tonga with respect to the supply of the products and services under the verified contracts;
8. to accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contracts such facilities as may be necessary for their entry into the Kingdom of Tonga and stay therein for the performance of their work;
9. to bear commissions, namely advising commissions of the Authorization to Pay (A/P) and payment commissions, to the Japanese bank for its banking services based upon the Banking Arrangement (B/A);
10. to provide necessary permissions, licenses and other authorization for implementing the Project, if necessary;
11. to ensure that the facilities constructed and equipment purchased under the Japan's Grant Aid be maintained and used properly and effectively for the Project; and
12. to bear all the expenses, other than those covered by the Japan's Grant Aid, necessary for the Project.

13

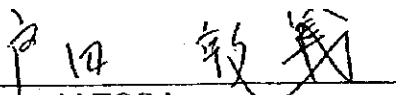
MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY ON THE PROJECT FOR
RENOVATION OF SEAWATER SUPPLY SYSTEM
IN THE KINGDOM OF TONGA
(Consultation on the Draft Basic Design)

The Japan International Cooperation Agency (hereinafter referred to as "JICA") sent to the Kingdom of Tonga the Basic Design Study Team on the project for renovation of the seawater supply system (hereinafter referred to as "the Project") in September 1998. Having conducted field surveys in the Kingdom of Tonga and technical examination in Japan, JICA prepared a draft basic design on the Project.

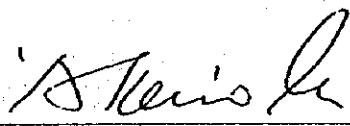
In order to explain and discuss with the Government of the Kingdom of Tonga the draft basic design, JICA has sent to the Kingdom of Tonga the Draft Basic Design Study Explanation Team (hereinafter referred to as "the Draft Team"), headed by Atsuyoshi TODA and expected to stay in the country from 9 through 12 December 1998.

As a result of discussions, both parties have confirmed the main items described on the attached.

Nuku'alofa, 11 December 1998



Atsuyoshi TODA
Leader
Basic Design Study Team
JICA



'AKAU'OLA, cvo
Secretary
Ministry of Fisheries



ATTACHMENT

I. MAJOR COMPONENTS OF THE PROJECT

| Elements | Components |
|---------------------------------------|---|
| 1. Seawater Intake System | Intake point: Groove of reef edge Intake capacity: 1.2m ³ /min Introduction pipe: 350mm dia., 500m (semi-siphon) Pipe materials: Coated steel pipe and PVC pipe Filtration system: Rapid-pressure filtration system Key equipment: - Intake pump 3 Units - Blower 4 Units - Vacuum pump 2 Units - Filtration unit 2 Units - Elevated tank 24m ³ - Piping renovation For main supply line |
| 2. Pump House | Structure: Reinforced steel concrete Floor area: Machine room 52.25m ² Filtration unit space 34.20m ² Elevated unit space 30.25m ² Total (116.70m ²) Intake pit: 4m dia., 5m depth Control Panel: 1 Unit |
| 3. Awning for Culture Area | Structure: Glued laminated timber Floor area, rearing space: 270.00m ² |
| 4. Drainage Canal and Settling Pond | Drainage canal: 0.4m width Structure: Reinforced concrete Settling basin: Structure Gravel laying bottom, Reinforced concrete for retaining walls |
| 5. Building Services | - Wiring, lighting and receptacle outlet 1 lot - Emergency generator 1 Unit - Plumbing for city water supply and sewerage 1 lot |
| 6. Equipment | FRP rearing tanks: - for giant clam 1.5m x 5.0m x 0.5m 10 units - for trochus or green snail 1.5m x 5.0m x 0.7m 10 units |
| 7. Night Worker's Station | Structure: Concrete block Floor area: Nap room 21.00m ² Restroom & Utility 21.00m ² Toilet & shower room 7.50m ² Total (49.50m ²) |
| 8. Demolishing of Existing Facilities | - 100m ³ reservoir - Octagonal tanks (2 x large tanks & 6 x small tanks) - Elevated tanks and basement - Overhead racks and pipes in the Wet Laboratory - Awning for rearing area. Etc. |



2. **OTHER DISCUSSED ITEMS**

1. The Draft Team has acknowledged the Government of Tonga's request for additional provision of ten 0.5 ton-tanks.
2. The Ministry has also expressed their need for training of a person presently assigned to its engineering section on the subject of repair and maintenance of the electrical machines and equipment that are to be provided under the Project.
3. In conjunction with the necessary excavation work under the road, the Ministry will consult with the Ministry of Public Works on the technical and regulatory aspects of its repavement.
4. The Ministry will make maximum efforts to minimize environmental effects caused by cutting of the mangrove trees.
5. The Draft Team will send a final report to the Government of the Kingdom of Tonga around March 1999,

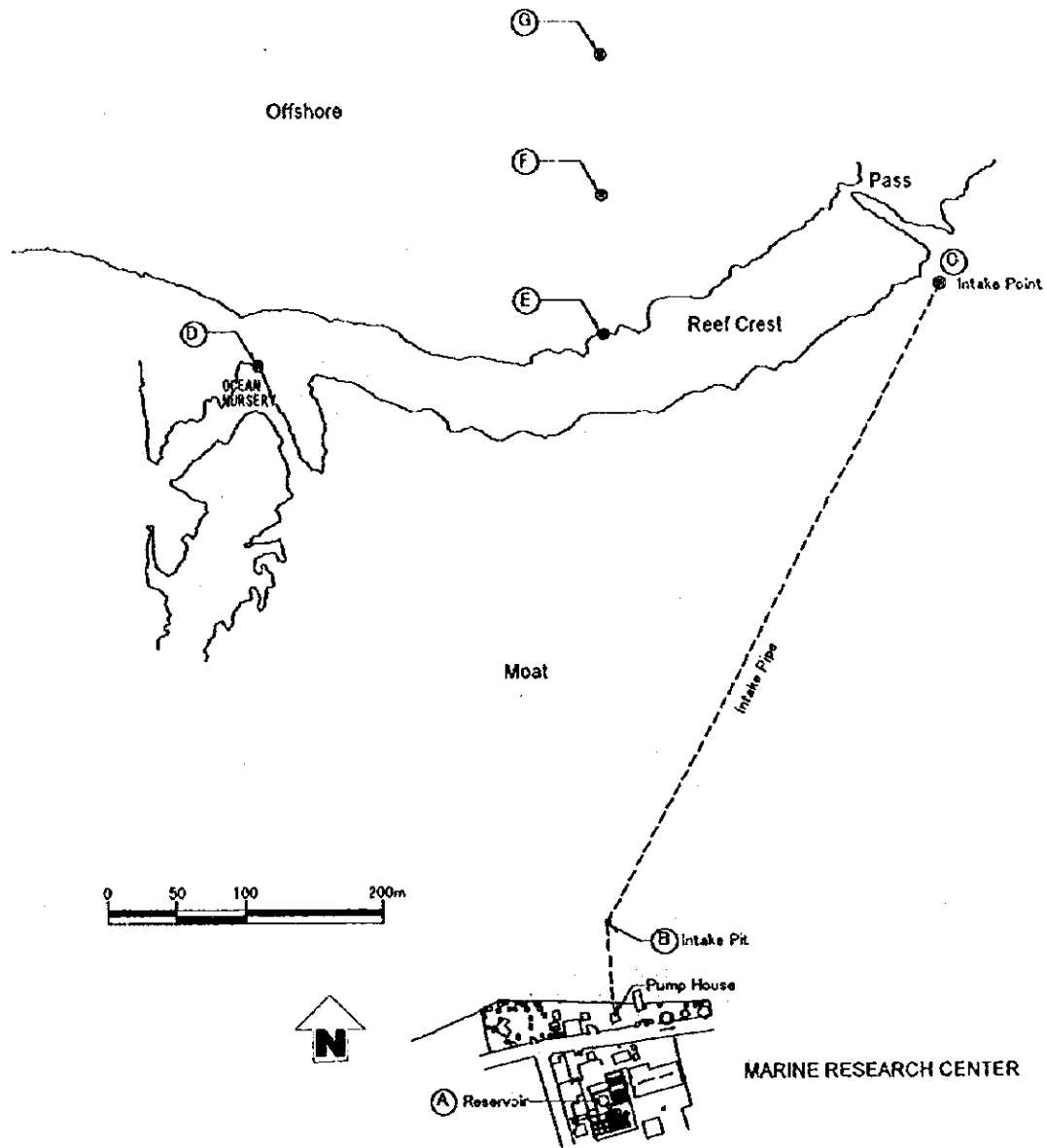
3. **RECONFIRMED MATTERS**

1. Both sides reconfirmed the items No.2, 6 and 9 of the Attachment of the previous minutes of discussion, dated on 2 October 1998.



5. Field Survey Results

5-1 Hydrographic Chart

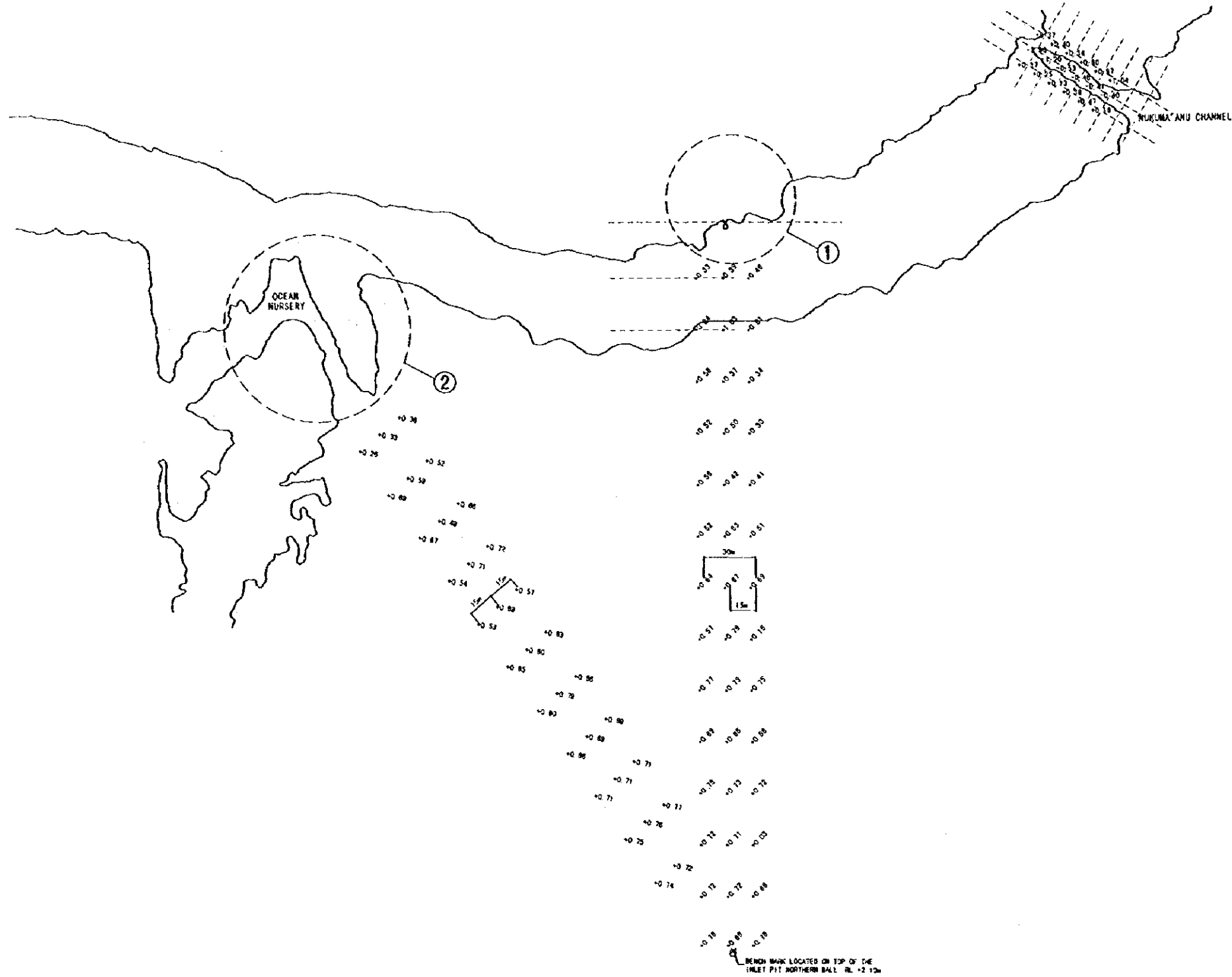


Location Map of Field Survey

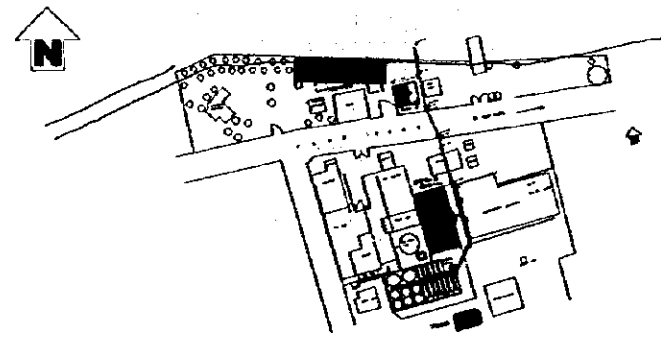
Contents of Field Survey Including :

- Hydrographic Survey (October 12 – October 13, 1998)
- Topographic Survey (October 5 – October 7, 1998)
- Tidal Current Observation (October 7 – October 8, 1998 : at Point G)
- Water Measurement at Sites (October 6 – October 13, 1998 : at Points A·B·C·D and E)
(December 19, 1998 : at Point F)
(October 7 – October 8, 1998 : at Point G)
- Microbiological Examination (Sampled on October 9 and 13, 1998 : from Points A·B·C·D and E)
- Water Quality Analysis (Sampled on October 15, 1998 : from Points E and D)
- Particle Size Analysis (Sampled on October 7, 1998 : from the bottom of Point F)

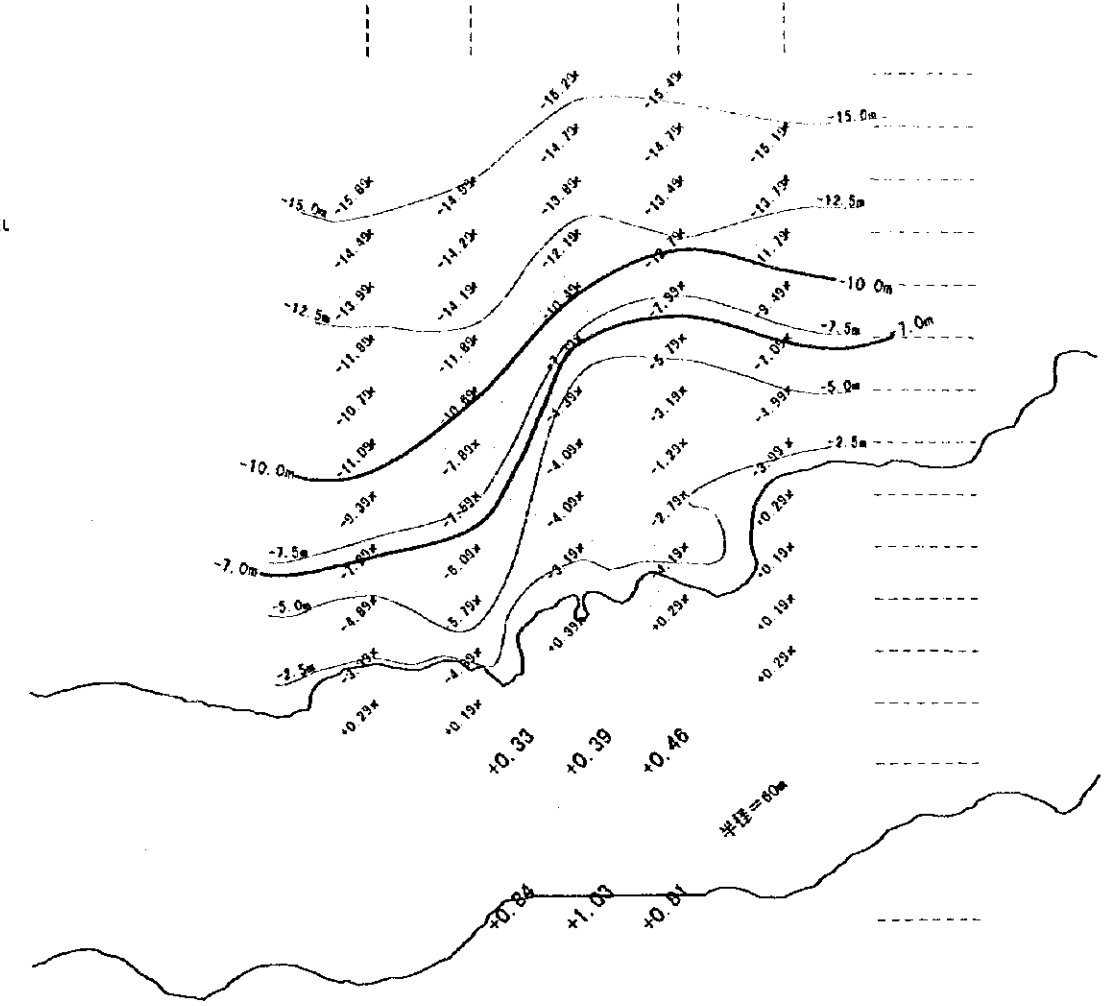
5-1 Hydrographic Chart



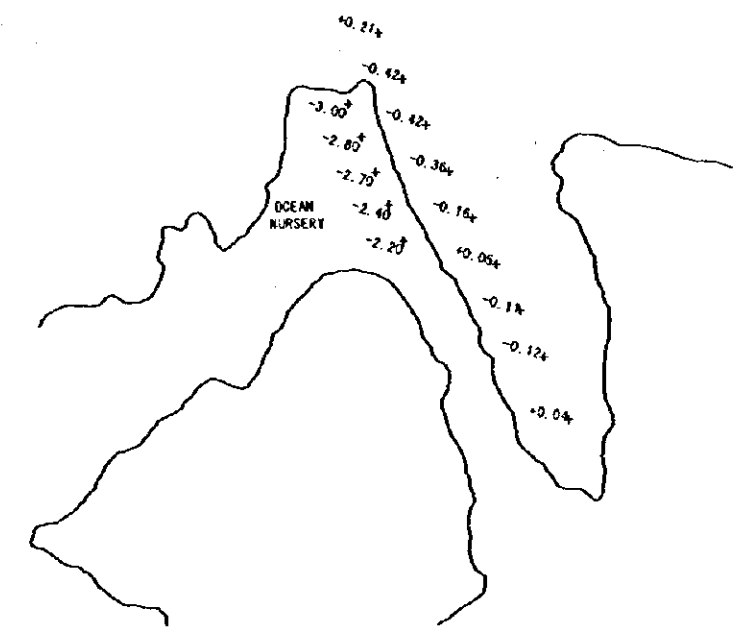
BENCH MARK LOCATED ON TOP OF THE INLET PIT NORTHERN BULL. RL. +2.12m



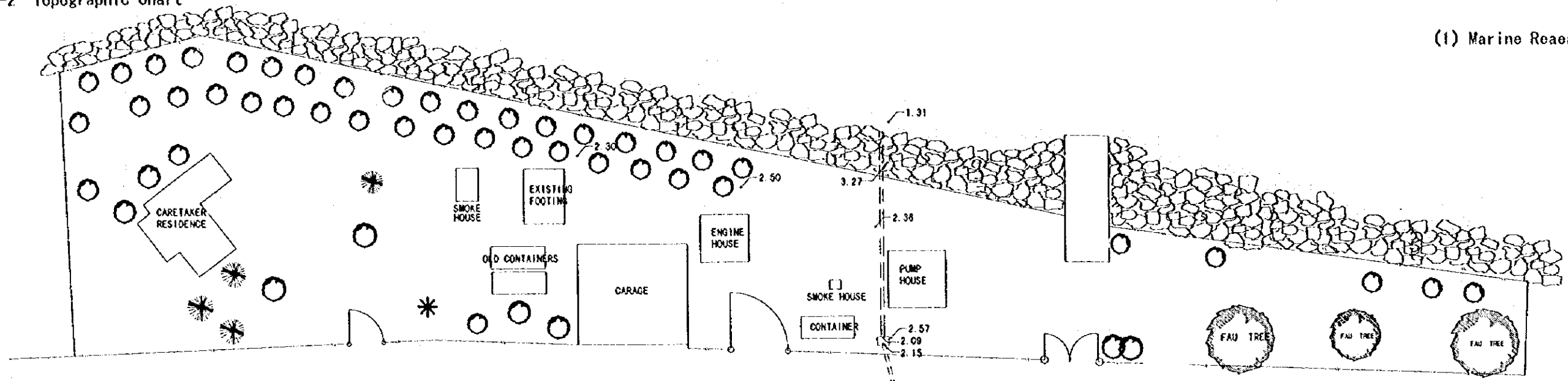
LOCATION PLAN



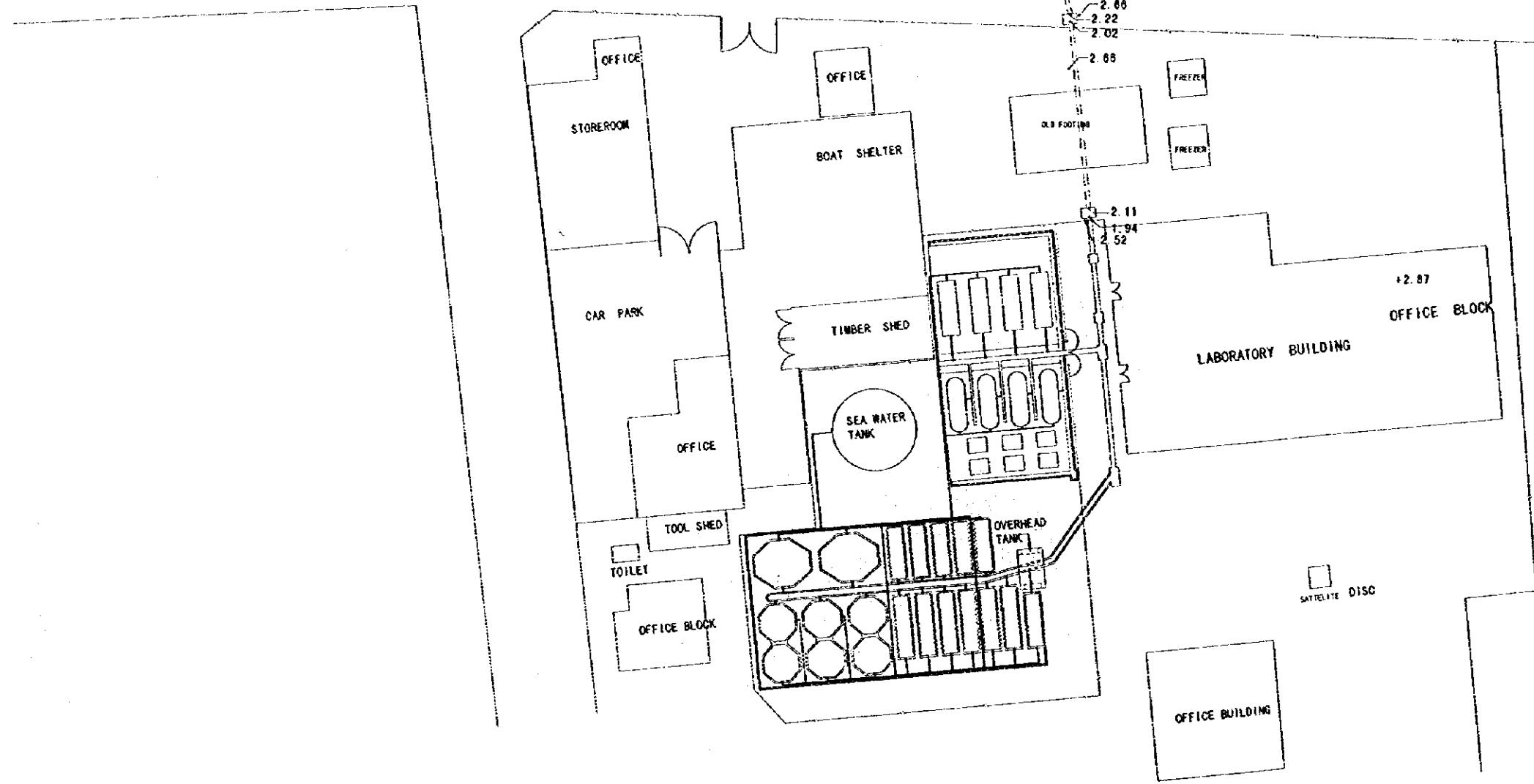
DETAIL 1



DETAIL 2



V U N A R O A D TO NUKU'ALOFA



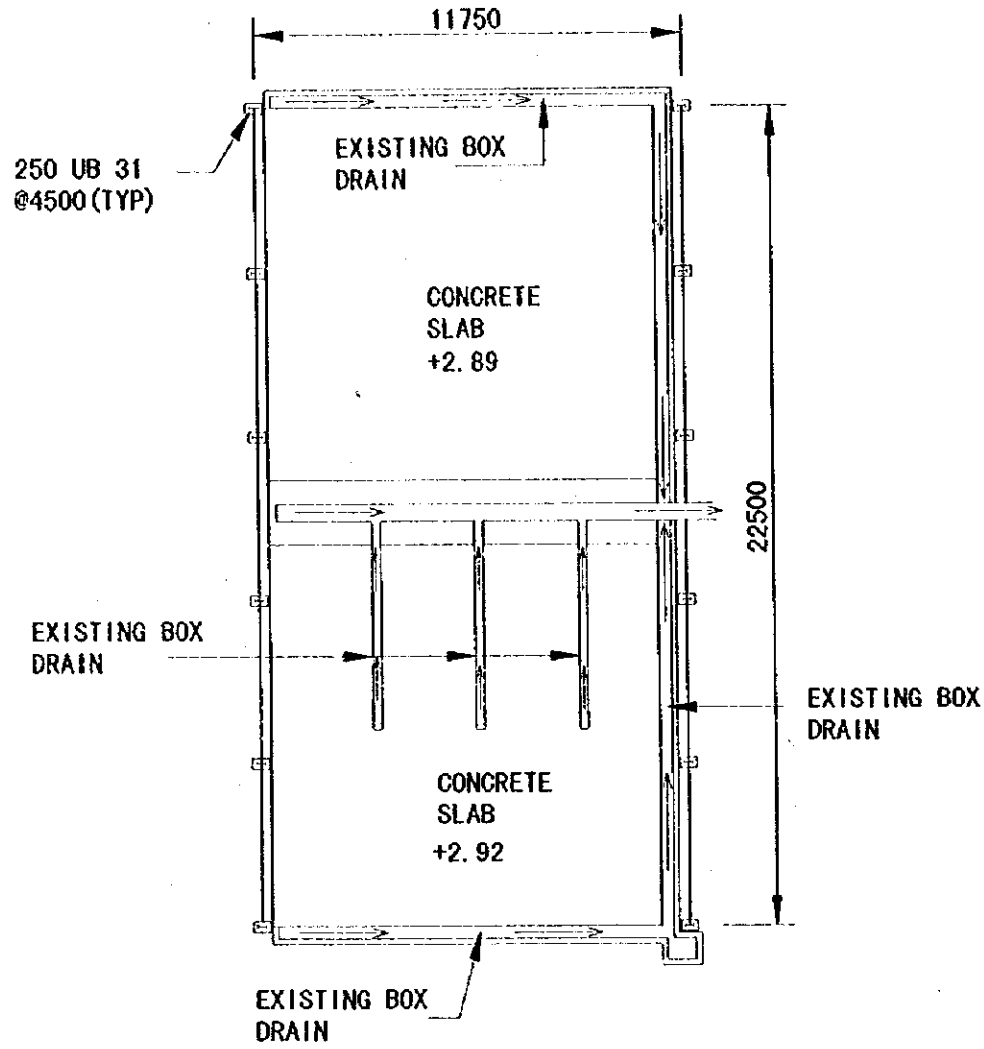
- LEGEND
- TELIE PLANT
 - COCONUT TREE
 - IRONWOOD TREE



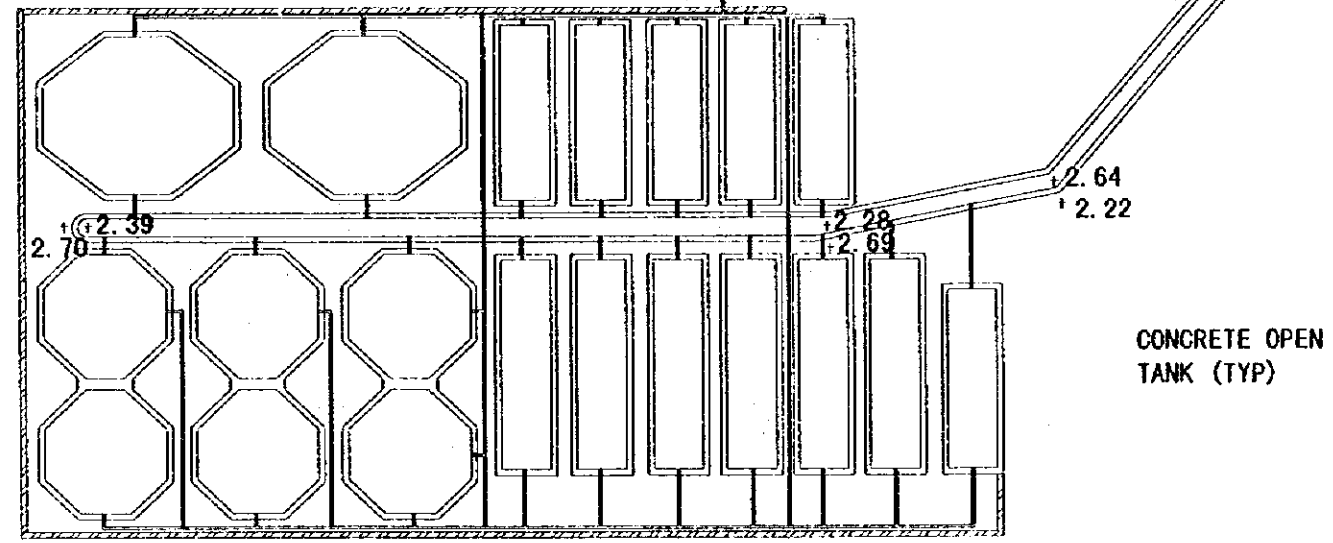
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| SURVEY | | DATE | SCALE | FISHERIES ENGINEERING CO. Ltd | |
| LHK | | | 1:250 | MASTER PLAN | |
| SURVEY CHECK | | | CAD FILE T247 | DRAWING NUMBER | |
| T'A | | | PLOT SCALE 1:1 | T247-S01 | |
| DRAWN | | | TECHNICAL APPROVAL | REVISION | |
| LHK | | | DATE | A | |
| DRAFTING CHECK | | | PROJECT APPROVAL | | |
| T'A | | | CLIENT APPROVAL | | |
| FM | | | | | |

KIMMEL KRAMER
 Kimmell Engineers Pty Ltd A.C.N. 007 660 317
 3rd FLOOR, MANUKA CENTER
 84 UFAWA
 P.O. BOX 938
 NUKU'ALOFA, TONGA
 TEL: 876 22 480 FAX: 876 22 181

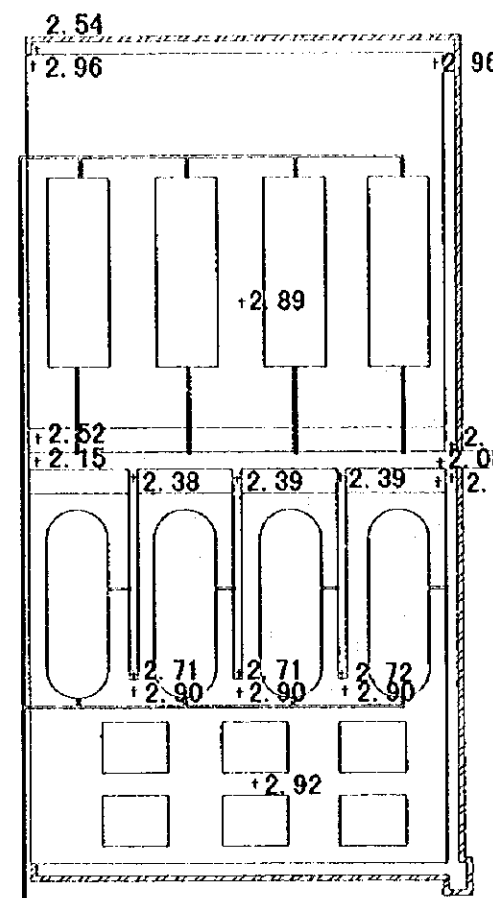
PLANE 801.666



CONCRETE OPEN TANK (TYP)



SEASHELL NURSERY



FIBREGLASS OPEN TANK (TYP)

FIBREGLASS OPEN TANK (TYP)

CONCRETE OPEN TANK (TYP)

(2) Detail of Rearing Area

EXISTING BOX DRAIN

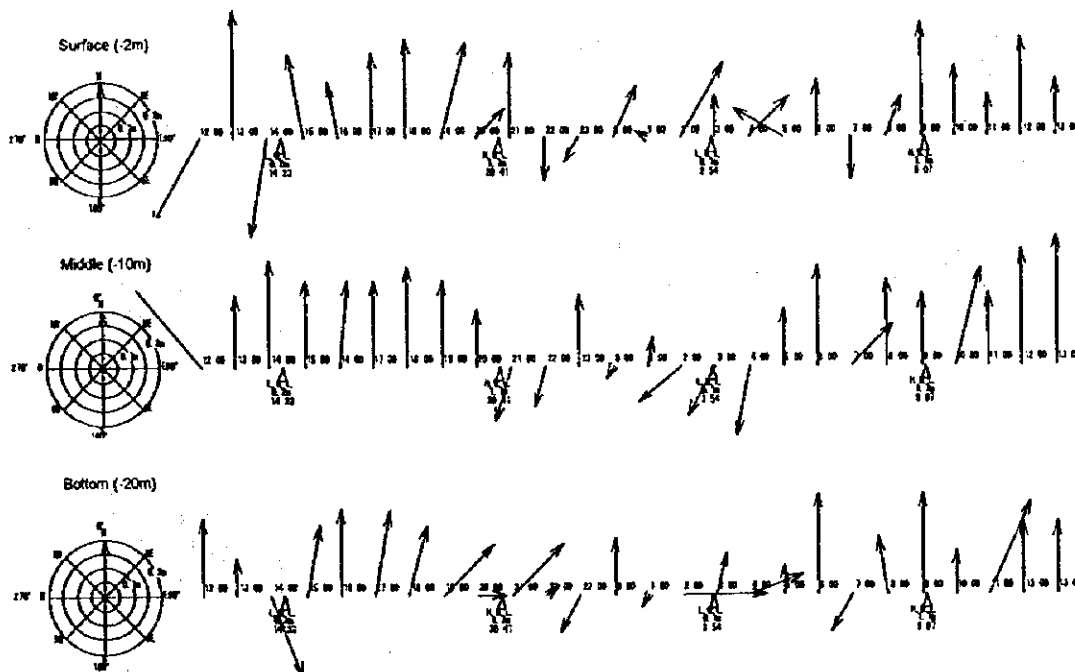


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| | | | | | | | SURVEY LHK SURVEY CHECK T'A DRAWN LHK DRAFTING CHECK T'A FIN | | | DATE SCALES 1:100 CAD FILE T247 PLOT SCALE 1:1 | | KIMMELL KRAMER Kimbell Engineers Pty Ltd A.C.N. 007 660 317 5-7 FLOOR, FANFANGA CENTER 88, 100 MARUA P.O. BOX 638 NURU ALFA, TORUA TEL. 076 22-480 FAX 076 22-191 | | FISHERIES ENGINEERING CO. Ltd DRAINAGE EXISTING LEVELS DRAWING NUMBER T247-S03 | | REVISED CODE A | |
| ISSUES | PROJ. SUP. | DWG. No. | TITLE | FOR INFORMATION | LHK | TA | DATE | DESCRIPTION | DRAFT | DES | PROJ. SUP. | CHIEF DRAFTER | FIN | CLIENT APPROVAL | PROJECT APPROVAL | TECHNICAL APPROVAL | DATE |

5-3 Tidal Current

Record of Tidal Current Observation

| Date | Time | Depth (m) | Velocity (m/s) | Direction (°) | Remarks | Date | Time | Depth (m) | Velocity (m/s) | Direction (°) | Remarks | Date | Time | Depth (m) | Velocity (m/s) | Direction (°) | Remarks |
|--------------|-------|-----------|----------------|---------------|---------|--------------|-------|-----------|----------------|---------------|---------|--------------|-------|-----------|----------------|---------------|---------|
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| | | -10.0 | 0.500 | 320 | | | | -10.0 | 0.050 | 210 | | | | -10.0 | 0.450 | 0 | |
| | | -20.0 | 0.350 | 0 | | | | -20.0 | 0.200 | 0 | | | | -20.0 | 0.250 | 0 | |
| | 13:00 | -2.0 | 0.450 | 0 | | | 1:00 | -2.0 | 0.050 | 300 | | | 11:00 | -2.0 | 0.200 | 0 | |
| | | -10.0 | 0.250 | 40 | | | | -10.0 | 0.100 | 10 | | | | -10.0 | 0.450 | 0 | |
| | | -20.0 | 0.130 | 0 | | | | -20.0 | 0.050 | 210 | | | | -20.0 | 0.250 | 0 | |
| | 14:00 | -2.0 | 0.350 | 190 | 14:23 | | 2:00 | -2.0 | 0.300 | 30 | 2:54 | | 14:00 | | | | |
| | | -10.0 | 0.370 | 350 | L.W.L. | | | -10.0 | 0.200 | 230 | L.W.L. | | | | | | |
| | | -20.0 | 0.300 | 160 | +0.2m | | | -20.0 | 0.300 | 50 | +0.1m | | | | | | |
| | 15:00 | -2.0 | 0.300 | 350 | | | 3:00 | -2.0 | 0.150 | 0 | | | 15:00 | | | | 15:15 |
| | | -10.0 | 0.300 | 0 | | | | -10.0 | 0.200 | 210 | | | | L.W.L. | | | +0.2m |
| | | -20.0 | 0.250 | 10 | | | | -20.0 | 0.150 | 15 | | | | | | | |
| 16:00 | -2.0 | 0.200 | 350 | | 4:00 | -2.0 | 0.200 | 45 | | 16:00 | | | | | | | |
| | -10.0 | 0.300 | 5 | | | -10.0 | 0.250 | 190 | | | | | | | | | |
| | -20.0 | 0.300 | 10 | | | -20.0 | 0.200 | 70 | | | | | | | | | |
| 17:00 | -2.0 | 0.300 | 0 | | 5:00 | -2.0 | 0.200 | 300 | | 17:00 | | | | | | | |
| | -10.0 | 0.300 | 0 | | | -10.0 | 0.200 | 0 | | | | | | | | | |
| | -20.0 | 0.300 | 10 | | | -20.0 | 0.100 | 0 | | | | | | | | | |
| 18:00 | -2.0 | 0.350 | 0 | | 6:00 | -2.0 | 0.200 | 0 | | 18:00 | | | | | | | |
| | -10.0 | 0.350 | 0 | | | -10.0 | 0.350 | 0 | | | | | | | | | |
| | -20.0 | 0.250 | 15 | | | -20.0 | 0.350 | 0 | | | | | | | | | |
| 19:00 | -2.0 | 0.350 | 15 | | 7:00 | -2.0 | 0.150 | 180 | | 19:00 | | | | | | | |
| | -10.0 | 0.300 | 0 | | | -10.0 | 0.200 | 45 | | | | | | | | | |
| | -20.0 | 0.250 | 45 | | | -20.0 | 0.150 | 210 | | | | | | | | | |
| 20:00 | -2.0 | 0.150 | 45 | 20:41 | 8:00 | -2.0 | 0.150 | 20 | | 20:00 | | | | | | | |
| | -10.0 | 0.200 | 0 | H.W.L. | | -10.0 | 0.300 | 0 | | | | | | | | | |
| | -20.0 | 0.100 | 180 | +1.7m | | -20.0 | 0.200 | 350 | | | | | | | | | |
| 21:00 | -2.0 | 0.300 | 0 | | 9:00 | -2.0 | 0.400 | 0 | 9:07 | 21:00 | | | | 21:33 | | | |
| | -10.0 | 0.200 | 195 | | | -10.0 | 0.250 | 0 | H.W.L. | | | | | H.W.L. | | | |
| | -20.0 | 0.250 | 45 | | | -20.0 | 0.350 | 0 | +1.7m | | | | | +1.7m | | | |
| 22:00 | -2.0 | 0.150 | 180 | | 10:00 | -2.0 | 0.250 | 0 | | 22:00 | | | | | | | |
| | -10.0 | 0.150 | 195 | | | -10.0 | 0.350 | 15 | | | | | | | | | |
| | -20.0 | 0.050 | 55 | | | -20.0 | 0.150 | 0 | | | | | | | | | |
| 23:00 | -2.0 | 0.160 | 210 | | 11:00 | -2.0 | 0.150 | 0 | | 23:00 | | | | | | | |
| | -10.0 | 0.250 | 0 | | | -10.0 | 0.250 | 0 | | | | | | | | | |
| | -20.0 | 0.150 | 210 | | | -20.0 | 0.350 | 25 | | | | | | | | | |



Date of Observation : 12:00 October 7 – 13:00 October 8, 1998
 Location of Observation : Point G (about 200 m off from the edge of reef crest)

5-4 Water Measurement Records

(1) Water Measuring Record at Site -1 (taken during field survey period)

| Location | Date and Time | pH | Conductivity (mS/cm) | Turbidity (NTU) | Temperature (°C) | Salinity (%) |
|-------------------|------------------|------|----------------------|-----------------|------------------|--------------|
| (A) Reservoir | 1998/10/6 12:07 | 7.16 | 63.3 | 2 | 30.4 | 4.00 |
| (B) Outside Pit | 1998/10/6 12:11 | 7.30 | 64.3 | 11 | 32.7 | 4.00 |
| (C) Water Intake | 1998/10/6 12:21 | 7.49 | 58.4 | 4 | 31.2 | 3.89 |
| (D) Ocean Nursery | 1998/10/6 12:38 | 7.36 | 62.1 | 0 | 29.2 | 4.00 |
| (E) Reef Crest | 1998/10/6 12:27 | 7.28 | 59.4 | 0 | 26.9 | 3.97 |
| (A) Reservoir | 1998/10/8 16:20 | 7.54 | 65.5 | 0 | 25.9 | 4.00 |
| (B) Outside Pit | 1998/10/8 16:07 | 7.64 | 65.6 | 0 | 26.1 | 4.00 |
| (C) Water Intake | 1998/10/8 15:32 | 7.59 | 61.0 | 2 | 28.2 | 4.00 |
| (D) Ocean Nursery | 1998/10/8 15:52 | 7.42 | 63.1 | 1 | 26.8 | 4.00 |
| (E) Reef Crest | 1998/10/8 15:43 | 7.24 | 62.7 | 1 | 26.3 | 4.00 |
| (A) Reservoir | 1998/10/9 16:10 | 7.48 | 61.4 | 2 | 27.5 | 4.00 |
| (B) Outside Pit | 1998/10/9 15:58 | 7.57 | 63.5 | 2 | 27.6 | 4.00 |
| (C) Water Intake | 1998/10/9 15:45 | 7.41 | 59.7 | 2 | 26.4 | 4.00 |
| (D) Ocean Nursery | 1998/10/9 15:27 | 7.39 | 61.3 | 0 | 26.0 | 4.00 |
| (E) Reef Crest | 1998/10/9 15:15 | 7.35 | 61.4 | 1 | 26.3 | 4.00 |
| (A) Reservoir | 1998/10/13 10:20 | 7.51 | 64.0 | 3 | 28.6 | 4.00 |
| (B) Outside Pit | 1998/10/13 9:12 | 7.32 | 62.9 | 3 | 26.2 | 4.00 |
| (C) Water Intake | 1998/10/13 9:25 | 7.31 | 62.6 | 4 | 24.9 | 4.00 |
| (D) Ocean Nursery | 1998/10/13 9:45 | 7.19 | 63.6 | 3 | 24.7 | 4.00 |
| (E) Reef Crest | 1998/10/13 9:34 | 7.20 | 62.7 | 1 | 25.4 | 4.00 |

Remarks : Measured by Horiba Water Checker U-10. Maximum salinity reading of U-10 is limited up to 4.00%.

(2) Water Measuring Record at Site -2 (taken during draft report consultation period)

Date : December 10, 1998

Location : Point F (about 100 m off from the edge of reef crest)

| Time | Tide Level (m) | Air Temperature (°C) | Water Depth (m) | Water Temperature (°C) | pH | Salinity (%) |
|-------|----------------|----------------------|-----------------|------------------------|------|--------------|
| 06:45 | +0.4 | 27.0 | 2 | 27.8 | 7.36 | 3.7 |
| | | | 10 | 28.0 | 7.37 | 3.7 |
| | | | 17 | 27.0 | 7.37 | 3.7 |
| 10:00 | - | 31.5 | 2 | 28.5 | 7.33 | 3.8 |
| | | | 10 | 28.0 | 7.35 | 3.7 |
| | | | 17 | 28.0 | 7.40 | 3.5 |
| 13:09 | +1.5 | 32.8 | 2 | 30.2 | 7.39 | 3.6 |
| | | | 10 | 28.7 | 7.43 | 3.7 |
| | | | 17 | 27.9 | 7.44 | 3.8 |
| 16:00 | - | 30.5 | 2 | 29.0 | 7.40 | 3.7 |
| | | | 10 | 28.8 | 7.41 | 3.7 |
| | | | 17 | 27.9 | 7.37 | 3.7 |
| 18:40 | +0.5 | 29.1 | 2 | 29.5 | 7.53 | 3.8 |
| | | | 10 | 28.5 | 7.44 | 3.6 |
| | | | 17 | 28.2 | 7.45 | 3.5 |

Remarks : Measured by using following equipment :

Temperature : Mercury filled thermometer

pH : Central Kagaku pH meter UC-23

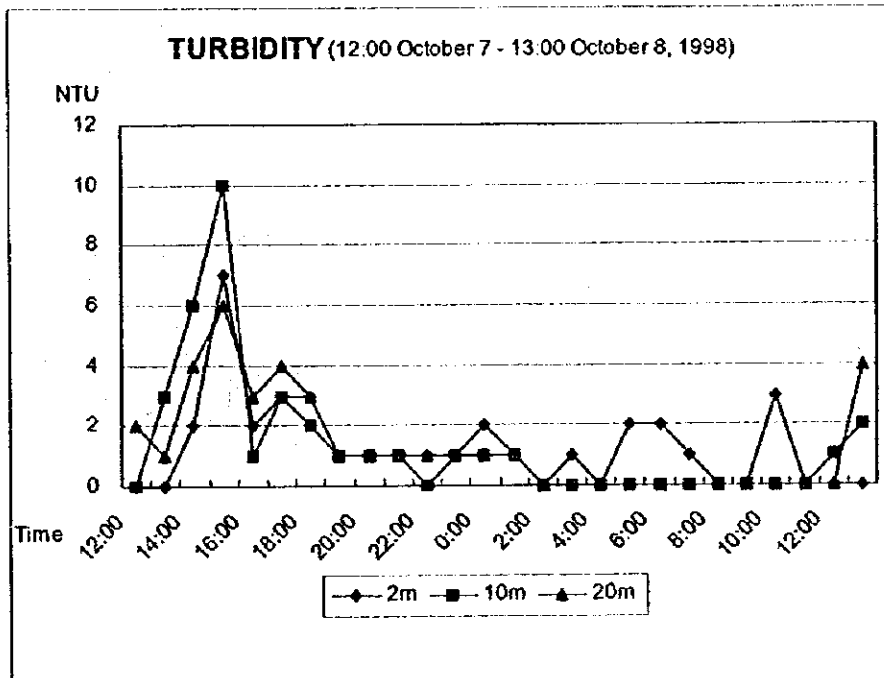
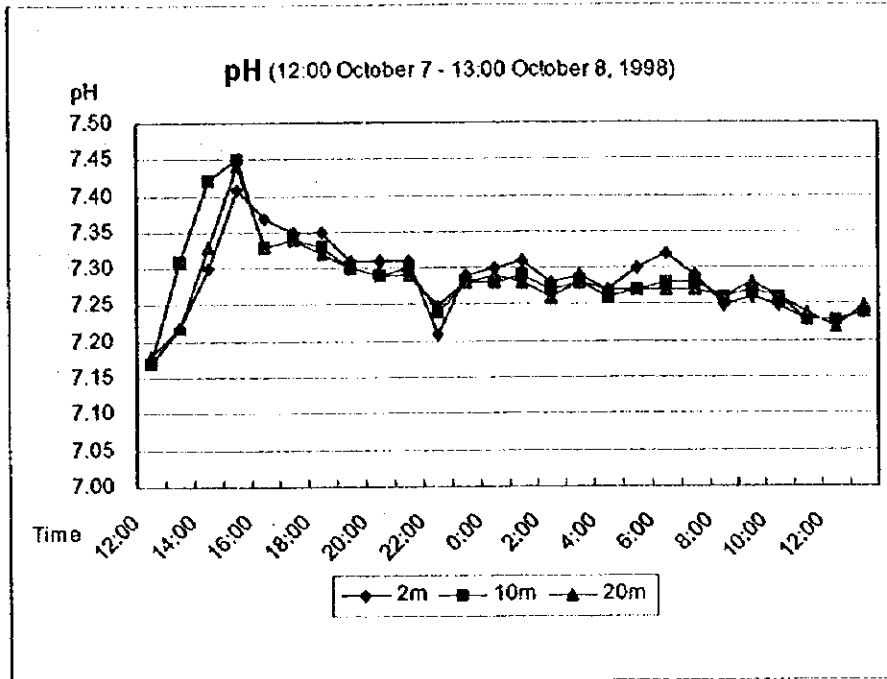
Salinity : Atago salinity refractometer S-100

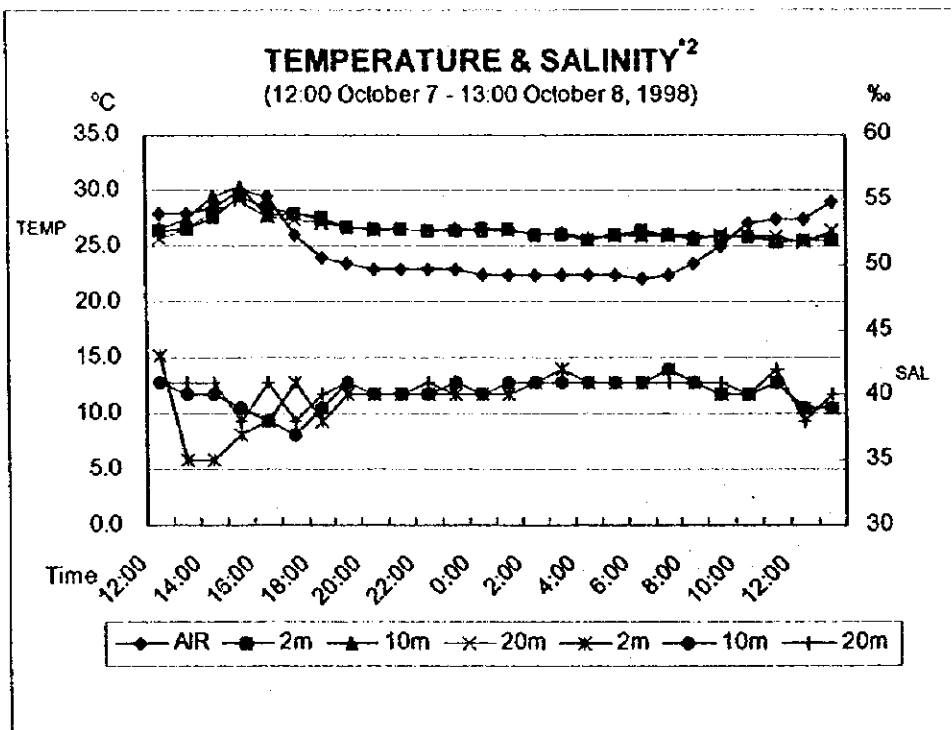
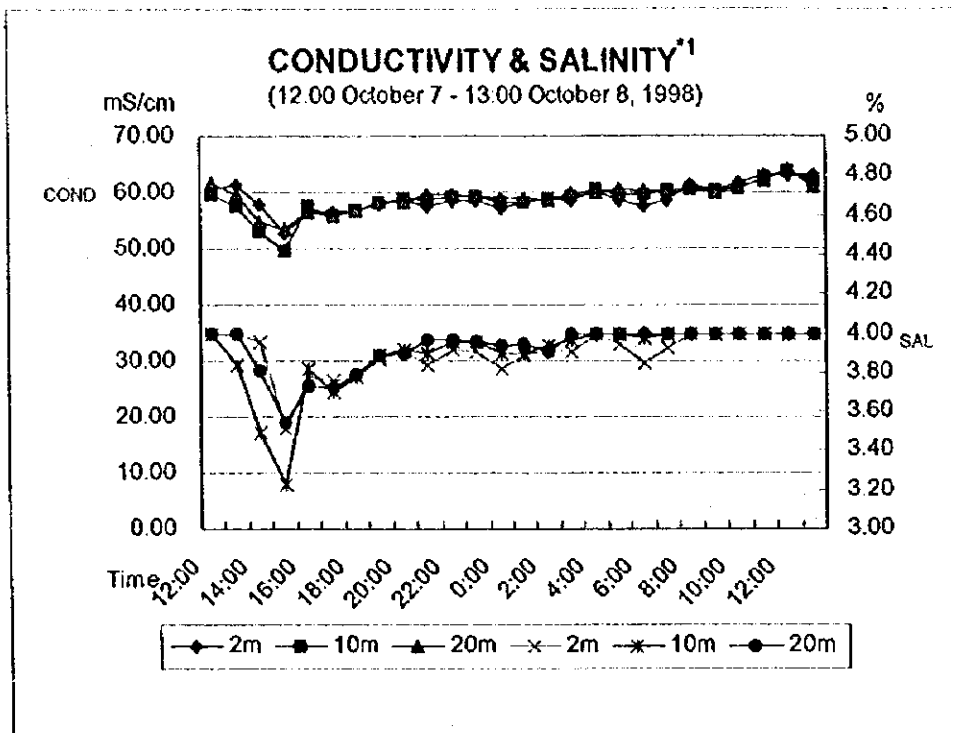
(3) Water Measuring Record at Site -3 (taken during period of tidal current observation)

Measuring Period : 12:00 October 7 - 13:00 October 8, 1998

Measuring Location : Point G (about 200 m off from the edge of reef crest)

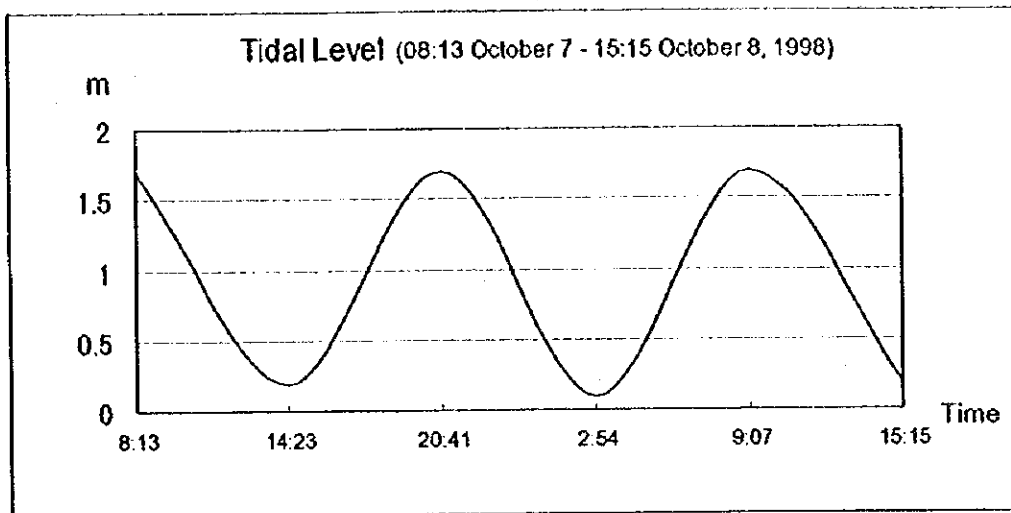
Used Equipment : Horiba U-10 (used Atago salinity refractometer S-100 for SALINITY*2 measuring)





Remarks: Measured SALINITY*1 by Horiba U-10
 Measured SALINITY*2 by Atago salinity refractometer S-100

Tidal Level during Water Survey Period



(4) Microbiological Examination

Most Probable Number per 100 ml of Sampled Seawater

| Examined Item | Total Bacteria ^{*1)} | | Total Coliform ^{*2)} | | Vibrio Group ^{*3)} | |
|-------------------|-------------------------------|-------------------|-------------------------------|-------------------|-----------------------------|-------------------|
| | 98/10/09 | 98/10/13 | 98/10/09 | 98/10/13 | 98/10/09 | 98/10/13 |
| (A) Reservoir | 5.7×10^4 | 5.8×10^4 | 6.0×10^3 | 6.0×10^3 | 1.6×10^4 | 5.0×10^3 |
| (B) Outside Pit | 1.3×10^5 | 1.1×10^5 | 6.0×10^3 | 4.5×10^3 | 1.1×10^4 | 7.0×10^3 |
| (C) Water Intake | 4.9×10^4 | 2.2×10^4 | 6.3×10^3 | 2.0×10^3 | 2.0×10^3 | 5.5×10^3 |
| (D) Ocean Nursery | 1.2×10^4 | 1.2×10^4 | 1.2×10^3 | 5.5×10^3 | 1.0×10^3 | 3.0×10^3 |
| (E) Reef Crest | 1.9×10^4 | 0.9×10^4 | 4.0×10^3 | 4.0×10^3 | 6.5×10^3 | 1.0×10^3 |

Culture Media : Sun Chemical "New Stamp" (applied with 35% salt water)

1) Standard Methods Agar 2) Desoxycholate Agar 3) TCBS Agar

Methods : Following applied 0.1 ml of sample seawater, incubated 24 hrs at 37°C, then most probable number of colonies were counted.

5-5 Water Quality Analysis

Results of Seawater Quality Analysis -- Comparison with Water Standards for Fisheries*¹

(Unit : mg/l)

| Analyzed Item | (D) Ocean Nursery | (E) Reef Crest | Water Standards for Fisheries* ¹ | Methods (Methodological Specification) | Minimum Reading |
|------------------|-------------------------|----------------------|---|---|--------------------|
| Suspended Solid | 1 | 1 | (Artificial addition) 2 | Gravimetry (Environment Agency Notice Annex-1, No. 59, 1971) | 1 |
| Total Phosphate | 0.04 | 0.01 | Category 1 0.03 Category 2 0.05 Category 3 0.09 | Absorption spectrophotometry (JIS* ² K0102 46.3) | 0.01 |
| Total Nitrogen | 1.8 | 1.1 | Category 1 0.3 Category 2 0.6 Category 3 1.0 | Ultraviolet rays absorption spectrophotometry (JIS K0102 45.2) | 0.01 |
| Total Mercury | - | <0.0005 | 0.0001 | Reduction vaporizing atomic absorption photometry (Environment Agency Notice Annex-1, No. 59, 1971) | 0.0005 |
| Cadmium | - | <0.001 | 0.0001 | Electrothermal atomic absorption spectrophotometry (JIS K0102 55.3) | 0.001 |
| Lead | - | <0.005 | 0.003 | Electrothermal atomic absorption spectrophotometry (JIS K0102 54.3) | 0.005 |
| Chromium (VI) | - | <0.02 | 0.01 | Diphenylcarbazide absorption spectrophotometry (JIS K0102 65.2.1) | 0.02 |
| Nickel | - | <0.005 | 0.01 | Electrothermal atomic absorption spectrophotometry (Environmental Quality Standards for Water Pollution Annex-7, No. 121) | 0.005 |
| Iron | - | <0.01 | 2 | Electrothermal atomic absorption spectrophotometry (JIS K0102 56.2) | 0.01 |
| Copper | - | <0.01 | 0.005 | Electrothermal atomic absorption spectrophotometry (JIS K0102 52.2) | 0.01 |
| Zinc | - | <0.01 | 0.01 | Electrothermal atomic absorption spectrophotometry (JIS K0102 53.2) | 0.01 |
| Cyanide | - | <0.05 | Shall not be detected | 4-Pyridinecarboxylic acid-pyrazol absorption spectrophotometry (JIS K38.3) | 0.05 |
| Nitrate Nitrogen | - | <0.04 | 10 | Absorption spectrophotometry (JIS K0102 43.2) | 0.04 |
| Nitrite Nitrogen | - | <0.04 | 0.06 | Absorption spectrophotometry (JIS K0102 43.1) | 0.04 |
| Ammonia Nitrogen | - | <0.1 | 0.002 | Absorption spectrophotometry (JIS K0102 42.2) | 0.1 |

Water Sampling Date : October 15, 1998 (Ocean Nursery at 9:40, Reef Crest at 9:20)

Analyzed by : Kankyo Engineering Co., Ltd., Tokyo, Japan

Certification Number for Analysis : 38A10211-1 and 38A10211-2

Completion Date of Analysis : November 2, 1998

*¹ Water Standard for Fisheries : Compiled by Japan Fisheries Resource Conservation Association (1995)

*² JIS : Japanese Industrial Standards

5-6 Particle Size Analysis

HORIBA CAPA-300 PARTICLE ANALYZER

DATE H10.10.28

SAMP. 水産エンジニアリング 海底土

DISP. グリセリン/水 = 10/30

*CONDITIONS

DISP. VISC. 18.00 [C/P]
 DISP. DENS. 1.18 [G/CC]
 SAMP. DENS. 3.00 [G/CC]

D (MAX) 100.00 [PM]
 D (MIN) 1.00 [PM]
 D (DIV) 0.80 [PM]

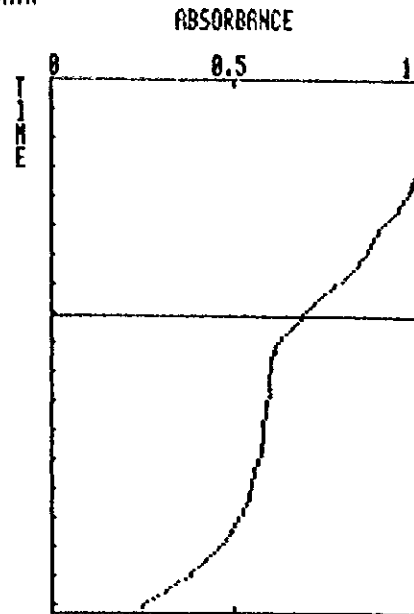
SPEED 0 [RPM]
 1500 [RPM]

TIME GS 0 H 7 M 34 S
 CS 0 H 16 M 2 S

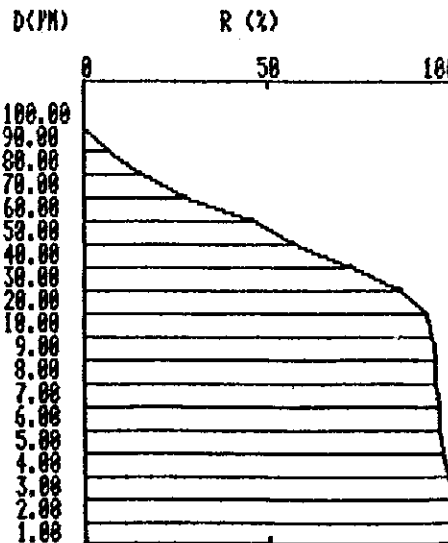
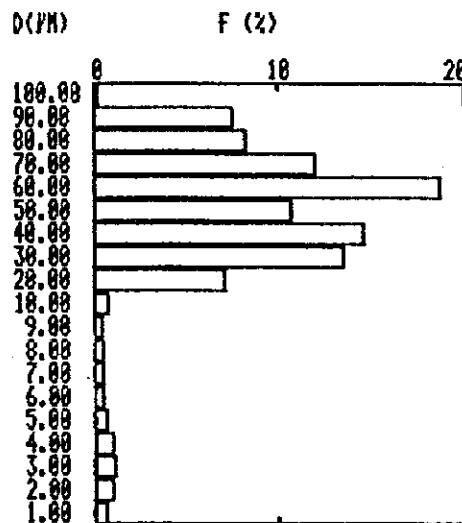
* DISTRIBUTION TABLE (BY VOL.)

| D (PM) | F(%) | R(%) |
|---------------|------------|-------|
| 100.00< | 0.0 | 0.0 |
| 100.00- 90.00 | 0.2 | 0.2 |
| 90.00- 80.00 | 7.6 | 7.8 |
| 80.00- 70.00 | 8.3 | 16.1 |
| 70.00- 60.00 | 12.8 | 28.1 |
| 60.00- 50.00 | 18.7 | 46.8 |
| 50.00- 40.00 | 10.7 | 57.5 |
| 40.00- 30.00 | 14.6 | 72.1 |
| 30.00- 20.00 | 13.5 | 85.6 |
| 20.00- 10.00 | 7.2 | 92.8 |
| 10.00- 9.00 | 0.8 | 93.6 |
| 9.00- 8.00 | 0.4 | 94.0 |
| 8.00- 7.00 | 0.5 | 94.5 |
| 7.00- 6.00 | 0.5 | 95.0 |
| 6.00- 5.00 | 0.5 | 95.5 |
| 5.00- 4.00 | 0.7 | 96.2 |
| 4.00- 3.00 | 1.0 | 97.2 |
| 3.00- 2.00 | 1.1 | 98.3 |
| 2.00- 1.00 | 1.0 | 99.3 |
| 1.00- 0.00 | 0.7 | 100.0 |
| D (MEDIAN) | 47.01 (PM) | |

* DATA



* DISTRIBUTION GRAPH (BY VOL.)



Date of Sampling : October 7, 1998

Sampling Point : From the bottom of Point F (about 100 m off from the edge of reef crest)

JICA