DRAFT REPORT OF SURVEY
FOR
THE PLANNING OF
BRACKISH WATER FISH CULTURE STATION
AT HIGANES, PANAY ISLAND,
PHILIPPINES

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN
Tokyo, Japan
June, 1977

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PREFACE

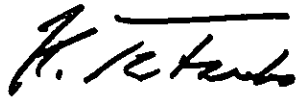
The Overseas Technical Cooperation Agency (OTCA) has the pleasure of presenting the survey report on the Planning of Brackish Water Fish Culture Station at Leganes, Panay Island, of the study group of five experts headed by Dr. Kuronuma, which was organized and dispatched to the Republic of the Philippines by the OTCA at the request of the Southeast Asian Fisheries Development Center, under the instruction of the Fourth Meeting of its Council as a preliminary survey on the establishment of its Aquaculture Department.

The study group of experts stayed in the Philippines from March 11 to April 15, 1971 and successfully completed the field survey including discussion and interview with the authorities concerned, and collection of informations and data with whole hearted cooperation from the Government of the Philippines and other relevant organizations.

After their return to Japan, the study group of experts made further studies on data and informations, and the results were hereby compiled into the present report for presentation.

Finally, on behalf of OTCA, I wish to take this opportunity to express my sincere gratitude to the Government of Philippines for the generous cooperation and assistance rendered to the group of experts during their stay.

July 1971



Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency
Tokyo, Japan

DRAFT REPORT OF SURVEY FOR THE PLANNING OF BRACKISH WATER FISH CULTURE STATION AT LEGANES, PANAY ISLAND, PHILIPPINES : MARCH 11 TO APRIL 15, 1971

(with 4 Tables, 27 Figures and 10 Photographs)

By THE JAPANESE SURVEY TEAM

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Report submitted to the Secretary-General, Southeast Asian Fisheries Development Center, Bangkok.

I INTRODUCTORY NOTES

The Fifth Ministerial Conference for the Economic Development of Southeast Asia, which was held at Jogjakarta, Indonesia, on May 23-25, 1971, issued a Joint Communique stating: "The Conference noted with appreciation the offer of the Philippine Government to host a Working Group Meeting in Manila to study the possibilities and scope of setting up a Department of Fresh and Brackish Water Fisheries of the SEADEC, A report of the Working Group will be presented to the Sixth Ministerial Conference. The Conference also noted the suggestion of the Delegation of Vietnam to equip one of the existing laboratories in Vietnam which may be used as a sub-station to study fresh water fishery."

The communique above was immediately carried into effect. The First Meeting of the Working Group of the Experts on Aquaculture was convened at Manila from July 27 to August 1 in the same year at the invitation of the Government of the Philippines. This Meeting, attended by about 30 experts and other personnel representing Member Governments of the SEAFDEC and other institutions, discussed the planning and operation of the proposed Aquaculture Department, the details of which are described in "Report of the First Meeting of the Working Group of Experts on Aquaculture. Southeast Asian Fisheries Development Center, Manila, Philippines, July 27-August 1, 1970." Among the recommendations made by the Meeting addressed to the Council are the following:

Recommendation 1: The proposed Department should be called the Aquaculture Department and its headquarters be established in the Philippines.

Recommendation 2: The scope of the proposed Department should embrace activities relating to research, training and extension in aquaculture with the following purpose and functions;

> Purpose : To contribute to the development of aquaculture in Southeast Asia by mutual cooperation among the member countries of SEADEC and through collaboration with international organizations or other non-member countries which are interested in the fisheries development in the region.
>
> Functions : (a) To promote, undertake and coordinate research, training and extension activities in the field of aquaculture in response to the needs of the member countries ; (b) To arrange for exchange of knowledge and dissemination of information in the field of aquaculture among member countries ; and (c) To undertake any related activities or programs as may be determined and instructed by the Council.

Recommendation 3: The Council should appoint a group of Experts or convene the second meeting of the present Group as soon as possible after it has decided to establish the Aquaculture Department under the aegis of SEADEC. This group should undertake detailed studies by consultations as well as by actual visits, and evaluate therefrom, in order to recommend in detail the organization plan, financial sources and contribution arrangement, plan of operation, actual location of suitable substations and specific programs of work, to the Council.

Further the Meeting resolved that the aquaculture in brackish water should be taken up firstly as the subject of the studies. Also the Meeting was informed by the

Government of Philippines that the Government is extremely anxious to establish the Aquaculture Department of SEADEC jointly with the national program on the same subject which is financially supported by USAID.

Following the progress of the project through those meetings, the Fourth Meeting of the Council of the Southeast Asian Fisheries Development Center was convened at Manila in January, 1971. Among the agenda discussed by the Council Meeting was the program of the Aquaculture Department which was well materialized. A few days prior to the opening of the Meeting the Japanese delegation, upon the invitation of the Government of the Philippines, made a one-day trip to the site of the aquaculture station at Leganes, Iloilo Province, Panay Island, which had been selected by the Philippine - USAID project as the site. The experts of the Japanese delegation felt the site was not unsuitable for the pond culture of shrimp.

At the Council, the Government of the Philippines, following suit, laid emphasis on the establishment of the SEAFDEC Aquaculture Station at Leganes, Panay Island. The proposal to this effect was expressed by the Minister of Agriculture and Natural Resources. The Council agreed to the proposal. The details of the Meeting are described in "Report of the Fourth Meeting of the Council of the Southeast Asian Fisheries Development Center; Manila, Philippines, January 18-22, 1971." During the discussions at the Meeting concerning the establishment of the SEADEC AQUACULTURE STATION at Leganes, Panay Island, the conditions for which the Government of Philippines would be responsible were brought up. Thus, the Council was informed that : (1) The Philippine Government will take necessary steps on a priority basis with regard to granting of legal status to the Department and privileges to its international staff. (2) Filipino staff to the Department would be provided on full time basis. (3) The Philippine Government would provide the proposed Department with necessary operating cost in addition to the operating expenses committed to its national project.

In view of the opinions expressed in the Meeting, the Council instructed the Secretary-General of SEAFDEC, to : (1) Make arrangements in consultation with the Government of Japan to dispatch in the immediate future a group of experts on fish pond designing to the Philippines to cooperate with the Philippine experts in the design of fish ponds that may be suitable to both national and SEAFDEC projects. (2) To prepare a plan of operation of the Aquaculture Department in consultation with the member governments and to sabmit subsequently this plan to the Council for approval. The Council also agreed that the proposed Aquaculture Department would give first priority in its activities to shrimp culture.

Under instructions of the Council issued at the Meeting, the Secretary-General took immediate action, approaching the Government of Japan to dispatch the survey team to the site in Philippines. The Japanese Government, formally accepting the request of the Secretary-General and the Government of the Philippines, decided to send a survey team of experts. The survey and related works were then effected by the survey team of five experts for more than a one-month period from March 11, 1971.

Members of the team

Dr. Katsuzo Kuronuma	Leader	Ex-President, Tokyo University of Fisheries
Dr. Takeichiro Kafuku	Biologist	Chief, Fish Culture Section, Fresh water Fisheries Research Laboratory
Dr. Kunihiko Shigeno	Fish Culturist	Chief, Kagoshima Prefecture Fisheries Experiment Station

Dr. Makoto Nakamura	Hydrologist	Chief, Laboratory of Coastal Improvement, National Research Institute of Agricultural Engineering
Mr. Akio Honma	Secretary	Science Officer, Research Section, Fisheries Agency

The present report was prepared by all the members participating in the survey; Dr. Kafuku drafted on materials especially on biological problems; Dr. Shigeno on the problems on aquaculture; Dr. Nakamura on hydrology and ponds; and Mr. Honma on geography and government relation. Dr. Kuronuma shared in the work of compilation of the drafts and the handling of general subjects. The illustrations in the report were made by Dr. Nakamura unless otherwise noted. Photographs inserted were taken in color by Dr. Kuronuma unless otherwise noted. The present report was printed in Japanese (100 copies) and in English (200 copies).

ACKNOWLEDGMENTS

The present survey was made possible by the assistance, cooperation and encouragement rendered by a number of people, and the members of the team express their deep appreciation to each of these people.

II PROGRESS OF THE SURVEY

The objectives of the present survey, as resolved at the Fourth Council Meeting, were to design fish ponds at the site in Leganes that would be suitable for both national and SEAFDEC projects, and to draw up a plan of operation for the SEADEC Aquaculture Department to be reported to the coming Council Meeting. Survey team felt it highly desirable to keep its emphasis on designing the ponds at the site, and also on the collection of informations and materials needed for the formulation of the plan of operation for the Aquaculture Department Leganes Station. The scope and program of the survey was delimited to the 7 major subjects as defined below.

(1) Careful studies on the working program and schedule presented by the Government of Philippines on the establishment of a Brackish Water Aquaculture Station, with the financial support of USAID, at Leganes, Panay Island.

(2) At the site, to survey on land, road, soil, water system, bank, nearby communities, sea-shore, sea-water and river-water; temperature, turbidity and salinity of the water; water flow in river and tidal fluctuation; biological nature of water; and other features as required.

(3) Visiting and interviewing personnel of the government offices, research institutions, and university and fishery enterprises in Iloilo City. Survey of living conditions in the same city.

(4) Observation and survey on fish ponds, shore line and fishing community around Iloilo City.

(5) Collection of necessary information.

(6) Planning of the pond and other facilities required by the SEAFDEC Station at Leganes.

(7) General discussion to work out the principle, intention and process of the "coordination" in the two projects between SEAFDEC and the Government of Philippines (University of Philippines, National Science Development Board, USAID, etc.).

With the scope and program defined above, the survey team left Tokyo on March 11 for a period of one month. Arriving in Iloilo City, the team confirmed that the workers at Mindanao State University had succeeded in hatching and rearing shrimp larvae in tanks. The authorities of NSDB, which financed the shrimp culture project, strongly recommended that the team visit a sitc in Mindanao. Activing on the suggestion of NSDB and receiving permission from the Tokyo Government, two team members, Drs. Kuronuma and Shigeno, made a trip to Mindanao after finishing the scheduled works at Leganes and Manila City.

The itinerary and general progress of the survey are given below.

March 1971

11	(Thurs.)	Left Haneda airport by Japan Air Line plane at 1130 hours and arrived Manila City at 1500 hours.
12	(Fri.)	Discussions with Philippine counterpart members (12 men) about the survey program. Visits to Fisheries College, University of Philippines, and National Science Development Board exchanging views with the Chairman.
13	(Sat.)	Inspection trip to Navotas fishing harbor, International Rice Research Institute and Laguna Lake Fisheries Station at Los Banyos. Visit to Embassy of Japan.
14	(Sun.)	Trip to Central Luzon State University to meet the President. Inspection of the site of GOP-USAID-sponsored Freshwater Fish Culture Station.
15	(Mon.)	All-day discussion with Philippine counterpart members (5 men) at Embassy of Japan.
16	(Tues.)	Visit to Philippine Fisheries Commission to meet the Commissioner. Visit to the Laguna Lake Development Authority to hear explanation of the project.
17	(Wed.)	Left Manila City by Philippine Air Line plane at 1510 hours and arrived Iloilo City at 1640 hours. Discussions on the survey program at Ledesma Hotel.
18	(Thurs.)	Visit to Department of Botany, University of Philippines of Iloilo. Witnessed the lease of the site from the Leganes Municipality to Philippine Government at Leganes Town Hall. Inspection of the site.
19	(Fri.)	Visit to City Hall of Iloilo City to meet the mayor. Visit to Central Philippine University and inspection of the classes of Zoology, Botany, Chemistry and Physics.

20	(Sat.)	Request of the extension of the survey to Mindanao Island sent to the Embassy of Japan. Left Iloilo City at noon and arrived at Dumangas to inspect the harvest of milkfish at the Fish Farm of Mr. Jamandre.
21	(Sun.)	Returned from Dumangas. Visit to the residence of Ex-Governer of Iloilo Province. Checking of instruments and tools.
22	(Mon.)	Survey at the site on land, water and organisms from 1000 to 1600 hours. Visit to the residence of Leganes Mayor, where instruments and tools were to be deposited during the survey.
23	(Tues.)	Survey as previous day.
24	(Wed.)	Survey as previous day. Visit to the boarding house of the Japan Overseas Cooperation Volunteers.
25	(Thur.)	Inspection of the Fish Farm at Zarraga of Mr. Jamandre. Survey of the waters surrounding the site.
26	(Fri.)	Hydrological survey of Gui-gui creek and shore water at the estuary.
27	(Sat.)	Measurements on hydrology at 2 stations established in Gui-gui creek and Jalaud river.
28	(Sun.)	Trip to Guimaras Island. Dinner party and free discussions at the invitation of the Philippine Research Society on Fish Culture.
29	(Mon.)	Trip to Anhawan Beach to inspect poultry, pig-rearing and fish culture. Visit to Philippine Fisheries Commission, Molo Office.
30	(Tues.)	Information received that Dr. T. Ino, SEAFDEC, visiting Manila on April 7. Visits to Governments offices in Iloilo City, including Bureau of Irrigation, Agricultural Production Commission, Weather Station, Burean of Plant Industry, Bureau of Public Works Hydrology Section, Bureau of Animal Husbandry, Bureau of Soils.
31	(Wed.)	Visits to fishery enterprises in Iloilo City including Refrigeration Plant of Mr. Doromal, Panay Ice Plant, Bormont Fishing Corporation, Fish Trading Co. of Mr. Jamandre and Central Market. Visit to Provincial Development Council in Governor's Office. Inspection of Agriculture Station, Bureau of Plant Industry.

April 1971

1	(Thur.)	Inspection of the beach and fishing activities on the southern coast of Panay Island extending eastward from Iloilo to Oton, Tigbauan, Guimbal, Dyungan, San Joaquin and Tiloas.
2	(Fri.)	Deposit of instruments and tools at Department of Botany, University of Philippines. Visits to Central Santos Lopez Sugar Plant, Dingle Dam and Farm Pond and Hatchery at Passisugar. Permission received from Tokyo Government on the extension of the survey.
3	(Sat.)	Early morning visit to market and collection of specimens. Visit to Admiral Fishing Corporation Refrigeration Plant (sole shrimp exporter in Iloilo).
4	(Sun.)	Discussion on buildings at the site. Left Iloilo City at 1730 hours and arrived Manila City at 1900 hours.
5	(Mon.)	Drafting of the report of survey.
6	(Tues.)	All day discussion with Philippine members (8) at Embassy of Japan.

7	(Wed.)	Visit to National Science Development Board to meet the Chairman.
8	(Thurs.)	Discussion with Philippine representatives (2), USAID personels (2) and Dr. T. Ino at Bay View Hotel.
9	(Fri.)	Kafuku, Nakamura and Honma left Manila City by Japan Air Line plane at 1450 hours and arrived Haneda at 2220 hours. Kuronuma and Shigeno made a trip to Cavite Province for inspection on agriculture.
10	(Sat.)	Rest.
11	(Sun.)	Left Manila City by Philippine Air Line plane at 0930 hours and arrived Cagayan de Solo, Mindanao at 1040 hours. Visit to Xavier University Oceanography Laboratory. Trip to Naawan for inspection of shrimp tank rearing at Marine Field Laboratory, Mindanao State University.
12	(Mon.)	Visit to Mindanao State University Campus and calling on the President. Inspection of Mr. Dimaporo's Fish Farm at Pangul Bay.
13	(Tues.)	Returned to Iligan City and left there by Philippine Air Line plane at 1240 hours. Arrived Mactan Airport at 1330 and left at 1730 hours. Arrived Manila City at 1900 hours.
14	(Wed.)	Visit to Overseas Technical Cooperation Agency Manila Office and Board of Technical Surveys of Maps. Talk with Mr. Imamura, Japan Overseas Cooperation Volunteer.
15	(Thur.)	Left Manila City by Japan Air Line plane at 0630 and arrived Haneda at 1325 hours.

To conduct field works at Leganes site, the Government of the Philippines generously provided five experts as counter-parts from the Philippines, and the survey was carried out under intimate cooperation between the two parties. Also, it was fortunate that Mr. Hideo Mochizuki, Japan Overseas Cooperation Volunteer, joined the field work at Leganes and made helpful contributions to the survey. During the visits to government offices, research laboratories and fishery enterprises in the city and the field trips to fish ponds, fishermen's communities and sea shore, the members of the Philippine Research Society on Fish Culture, Iloilo, extended to the team much assistance in many ways.

The names of the counterpart workers from the Philippine side and the persons contacted during the stay in the country are listed below.

Members of counterpart team from Philippines

Mr. Rogelio Juliano	Chairman	Dean, College of Fisheries, University of Philippines
Mr. Pedro Acosta	Secretary	Philippine Fisheries Commission
Mr. Jose M. Gerochi	Member	ditto
Mr. Melchor Lijauco	"	College of Fisheries, University of Philippines
Mr. Virgilio Doresa	"	ditto
Mr. Edurado Enderez	"	ditto

Dr. Elvira Tan	"	National Science Development Board
Mr. Jose Carreon	"	College of Fisheries, University of Philippines

(Persons underlined participated only in meetings)

Persons contacted during the survey trip to Philippines were as follows.

AMADO C. CAMPOS	President, Central Luzon State University
ROGELIO O. JURIANO	Dean, College of Fisheries, University of Philippines
MELCHOR M. LIJAUCO	Instructor, College of Fisheries, University of Philippines
JOSE A. CARREON	Director, Institute of Fisheries Development and Research, College of Fisheries, University of Philippines
VIRGILIO A. DUREZA	Researcher, ditto
EDUARDO ENDEREZ	Researcher, ditto
ANDRES M. MANE	Commissioner, Fisheries Commission
PEDRO A. ACOSTA	Staff, ditto
JOSE M. GEROCHI	Staff, ditto
ROBERTO E. FRONDA	Executive Director, National Food and Agriculture Council
FLORENCIO A. MEDINA	Chairman, National Science Development Board
ELVIRA O. TAN	Fisheries Officer, ditto
VINCENTE C. LAVIDES JR.	General Manager, Laguna Lake Development Authority
TEOLORO B. BAGUILAT	Manager, Planning, Research and Programming Division, ditto
MEDINA N. DELMENDO	Fishery Biologist, ditto
RICARDO L. ESQUERRA	Fishpond Loan Supervisor, Development Bank of the Philippines
CONCORDIA P. DE GOCO	Vice-President, Sinagoa Fishpond Inc.
MISAO YAMASAKI	Councellor, Embassy of Japan
KAZUHIRO MATSUSHITA	Second Secretary, ditto

YASUO KITANO	Resident Representative, Overseas Technical Cooperation Agency
TOMOHIRO IMAI	Japan Overseas Cooperation Volunteer
YOSHIYUKI FUJIWARA	ditto
TAKASHI INO	Deputy Secretary-General, Southeast Asian Fisheries Development Center (Bangkok)
PHILIP W. RUPPERT	Regional Industrial Enterprise Office, U.S. Embassy (Bangkok)
DOUGLAS L. TINSLER	Assistant Program Officer, U.S. Agency for International Development
DONALD R. YEAMAN	Staff, ditto
ADOLFO JAEN	Mayor, Leganes Municipality
REINBRIO J. TICAO	Mayor, Iloilo City
RAFAEL PALMARES	Ex-Governor, Iloilo Province
MARTIN DAQUILANEA, JR.	Assistant Executive Officer, Iloilo Provincial Development Council
ROSARIO DAQUILANEA	Science Promotion Officer, National Science Development Board (Iloilo)
RODOLFO T. LATAQUIN	District Engineer, Bureau of Public Works, Iloilo
LAURO DE VERA	Acting Officer-in-Charge, Fisheries Commission, Molo Station
JACINTO T. REYES	District Engineer, Bureau of Irrigation, Iloilo
JOSE K. SANTIAGO	Officer-in-Charge, Bureau of Plant Industry, Iloilo
DOMINADOR P. BANGAYLO	Acting Superintendent, Bureau of Plant Industry, Iloilo Experiment Station
EMIGADIO L. FABELLA	Regional Director, Bureau of Soils, Iloilo
MODESTO J. MAPESO	Supervising Field Veterinarian, Bureau of Animal Industry, Iloilo
J. L. BALIO	Provincial Agriculturist, Agriculture Productivity Commission, Iloilo
SULPICTO P. TADO	Officer-in-Charge, Weather Station, Iloilo
CESAR MONTELIBANO	Manager, Panay Ice Plant
PEDRO G. PADLAN	Director, Philippine Research Society on Fish Culture

TIRSO JAMANDRE, JR.	President, Philippine Research Society on Fish Culture
ERNEST V. JAMANDRE	Fish Culturist
ARNALDO BORRES	Bormont Fishing Corporation
JOSE P. COCJIN	Beach Resort, Oton
RAMON DOROMAL JR.	President, Panay Fisheries Products Cooperative Marketing Association
MAYO L. CARILLO	Manager, Central Santos Lopez Sugar Plant
VENACIO ALIGAEN	Professor, Department of Botany, University of Philippines, Iloilo
HIDEO MOCHIZUKI	Japan Overseas Cooperation Volunteer
MAUYAG TAMANO	President, Mindanao State University
MANAROS BORANSING	Vice-President, ditto
ALFREDO C. SANTIAGO	Professor, Sulu College of Technology and Oceanography
DOMICIANO K. VILLALUZ	Dean, College of Fisheries, Mindanao State University
ANTONIO VILLALUZ	Researcher, Mindanao State University Marine Laboratory
BIENVENIDO LADRERA	ditto
MADIO SHEIK	ditto
JAMER MCKROUGH	Father, Xavier University, Cagayan de Solo
DICASARAM DIMAPORO	Fish culturist, Lala, Mindanao

III THE SURVEY CONDUCTED AND THE RESULTS

In order to implement the survey and other works itemized into the 7 categories as formulated prior to departure for the Philippines, the survey team drew up a working program consisting of 3 procedures: (1) Survey work in the field: (2) Collection of information and materials: and (3) Visual observations.

At the station site, Leganes, the survey and other works were concentrated on studies of the general features in geography, topography and climate in the region, water system in and around the site, and fish ponds and its operations around the site. Actual survey works were conducted with emphasis especially on the tidal and level fluctuation of the waters in the sea and river, which is believed to be a key to the

designing of brackish water fish ponds; measurement of the salinity (associated with temperature) of the waters, also an important factor in determining eventual productivity of the fish and shrimp in ponds; turbidity of the sea water in the region, which will determine the feasibility of tank-rearing of larval shrimp. The change in the water levels and salinity was observed for a duration of 12 hours; salinity and turbidity were surveyed at 16 stations around the site.

The actually observed tidal fluctuation was correlated to the data recorded in the Tide Table, so that the true tidal fluctuation at the station site, Leganes, can be predicted by checking the table. In addition the highest possible efficiency of the tidal change was calculated with reference to how it is forwarded to the feeding of water to ponds; the same high efficiency was also computed for the flow of water in the supply canals and in the passage through the gates. The calculations thus made were used as the basis for the designing of these structures at the station. The mathematical formulas and the methods of the computations and its application to the designing are included in the present report as a source of reference. It may be mentioned that the conversion of the S.G. readings to the salinity was made based on the graph (Fig.26), which is also appended herein.

In addition to the works carried out on the site and adjoining areas, field trips were made to other places within the island and to Mindanao Island in order to substantiate the actual informations and visual observations on the problems concerning brackish water ponds, shore lines and waters, biology and fishing of shrimps and other related subjects. Other field trips along the Jalaud River up to a point about 70 km from its mouth provided some knowledge about the river, on which the station will depend as the source of freshwater and water of low salinity. The observations and studies thus made outside the Leganes site are referred to in relevant sections in the report.

1 Panay Island

Among some 3,000 islands with names in the Philippines, Panay Island, 11,400 km^2 wide and surrounded by fish-rich deep and shallow seas, is noted for its developed fishing industry (Fig.1). The annual products from the island amount to 65,000 tons (Table 1) of the total of 938,000 tons of the country. These statistical figures characterize the industry of the island. The annual fishery production of 65,000 tons is made up by the catches from the sea and the fish harvest from the brackishwater fish ponds represented by the milkfish or Chanos chanos or "bangus", as it is called locally, the letter accounting for half of the production. The percentage (51%), compared to the national total of 16 %, clearly indicates the vigorous activity of fish culture in Panay Island.

The island is divided by jurisdiction into 4 Provinces, Iloilo, Capiz, Aklan and Antique (Fig. 1), and the Sub-Province of Guimaras Island is placed under Iloilo Province (see Table 1 for the census of the provinces). Panay Island in its topography is generally mountainous, and the mountain range extends from north to south on the western part of the island approaching close to the coastal line; another major mountain range extends from west to east in the northern half of the island, but it leaves a narrow coastal plain on the coast. The southeastern portion of the island covering the greater part of Iloilo Province is in general a hillock plain but flanked by open flat land extending northward from Iloilo City and ranging along the eastern coast of the island. Cultivation of rice, sugar-cane, tobacco, vegetables, seed-crops and others is quite advanced on this flat land, much more so than in other regions within the island.

Table. 1. Census and fisheries activities by Provinces of Panay Island.[1]

	Province	ILOILO	CAPIZ	AKLAN	ANTIQUE
Census	Population	1,295,000	405,000	298,000	315,000
	No. of Municipalities	44	25	17	18
	No. of Cities	1	1		
	No. of coasatal Municipalities	23	7	10	15
	Coastal population	499,000	254,000	174,000	102,000
	No. of Barrios	1,692	411	305	558
Commercial fishing[2]	No. of licensed vessels	169	24	14	3
	No. of licensed fishermen	1,400	300	240	32
	Total tonnage of vessels	3,855	838	171	11
	Common fishing methods	Otter-trawl, Purse-seine, Round haul sein	Otter-trawl, Bagnet	Bagnet	Bagnet, deep water fish corrals
	Average annual catch (ton)	200 for trawlers per vessel	126 per trawler	7 per vessel	3 per vessel
	Total annual catch (ton)	15,195	3,034	100	3
Coastal aquaculture	Total area (ha)	16,429	16,686	2,600	125
	Estimated annual harvest (ton)	13,284	8,343	520	10
	Estimated no. of operators	991	351	120	47
	No. of farms	1,834	490	112	60
	Species produced	Milkfish, Shrimp,Tilapia, Freshwater-bass	Milkfish, Shrimp, Crabs, Tilapia	Milkfish, Shrimp, Crabs, Tilapia	Milkfish, Crabs, Shrimp, Tilapia
Marine municipal fisheries	Major fishing ground	Visayan-Sea, Guimaras-Strait, Iloilo-Strait, Panay-Gulf	Visayan-Sea	Visayan-Sea, Jintotolo-Channel	Cuyo-Pass
	Major commercial species	Anchovies, Slipmouth, Sardines, Croakers, Nemipterid, Shrimp, Round scad, Moonfish, Yaito tuna, Mackerel, Cavalla, Big eye-scad, Blue-fin tuna Spanish-mackerel, Milkfish fry,	Sardine, Herrings, Anchovies, Mackerel	Anchovies, Slipmouth, Mullet	Blue-fin tuna, Milkfish fry, Bonito
	Minor sea products	Kapis shell, Seaweeds, Oyster, Mussels	Kapis shell, Seaweeds, Mussels, Razer-clam	Sea shells, Seaweeds	

No. of fishing crafts	5,200	900	760	
No. of fishermen	3,300	3,400	2,300	
Common fishing methods	Fish corrals Beach-seine, Filter-net, Sardine gill-net, Push-net, Gill-net, Cast-net, Square lift-net,	Fish corrals, Beach-seine, Sardine gill-net, Push-net, Bag-net Cast-net,	Gill-net Hook-and -line	
Estimated annual catch (ton)	14,500	8,750	1,400	

1 Taken from "Inauguration and blessing ceremonies of the Regional Office Building. Philippine Fisheries Commission, Fisheries Regional Office No. V. Iloilo City. January 11, 1970".

2 Fishing season throughout the year for otter-trawlers; northern towns from March to October; southern towns of Iloilo from November to May.

Panay Island is, in a general, supported by the two industries, agriculture and fishery, which are centered in the north at Roxas City and in the south at Iloilo City, the latter being more highly developed both in physical and functional features.

The fish culture industry of Panay Island, where freshwaters bears almost no significance, can be said to be restricted to the brackish water pond culture. Naturally the industry has developed along the coastal line. Further, the species of fish handled, as mentioned before, is restricted to milkfish or "bangus". The available information indicates that the "bangus" ponds range on the estern and northern coasts of the island (Fig. 1), and their development on the western coast is negligible. The present survey disclosed that the westward ranging of the ponds terminated at Oton Municipality (Fig. 2), where the Iloilo and Batiano Rivers vanish.

According to statistics (Table 1), the brackish water ponds are nearly equally developed as far as their areas are concerned in Iloilo Province and Capiz Province (plus Aklan Province), but the amount of the crop and the numbers of the pond operators are greater in the first named Province. This fact is believed to prove the favorable conditions (higher-fish productivity and others) prevailing in Iloilo Province.

Within Iloilo Province the milkfish ponds range nearly throughout the coast from Oton (seea bove) northward to Carles (Fig. 1), indicating that the entire eastern coast of the province is suited to the culture. However, the productivity of the fish in ponds is not necessarily homogeneous within the range.

A survey in 1970 by the Fisheries Commission's Iloilo Regional Office classified the ponds by the amount of fish produced into 4 classes and by municipal regions as noted below :

First Class (1,000 kg/ha/year) :
Iloilo City, Anilao, Barotac Nuevo, Dumangas, Leganes and Zarraga

Second Class (800 kg) :
Banate, Balasan and Carles

Third Class (600 kg) :
Estancia, Ajuy, San Dionisio, Batad, Conception and Barotac Viejo

Fourth Class (400 kg) :
Buenavista, Jordan and Nueva Valencia

The classification of the ponds as noted above might have resulted from various underlying factors, perhaps the fertility of water and soil, water system, tidal change, climatic conditions, technical skill, financial back-ground, etc., but the classification points out one definite fact: that the milkfish culture on the coast of Iloilo Province has developed most extensively in its southern region concentrated around Iloilo City. The Leganes Municipality, where the Fish Culture Station under the two projects has been planned, falls in this region.

2 Iloilo City

Iloilo City with population of some 300,000 is the capital of the Province, and has developed as a center of commerce and trading in the Visayas (central Philippines). The city (N. Lat. 10°45" : E. Long. 122°30") is located on the delta of the Jaro and Iloilo Rivers (Fig. 2), facing Guimaras Island across the 3 km Iloilo Strait. Favored by such conditions, the city has developed into one of the important shipping ports in the Visayas, a fact which has obviously contributed to the development of the fishery industry in the region. Harbor, ship-yard, dock, market and cold-storage are the industries associated with the port.

The city is also playing a leading role in the region as the center of communications - air and sea. Airplanes fly daily from Manila to the city in 45 minutes, and passenger and freight liners connect Manila and the city in 20 to 24 hours. Within the island, Iloilo City is connected to Roxas City by railroad (a system developed only on this island in the Philippines with the exception of Luzon) ; long-distance bus service connects the city to most of the large towns and municipalities in the island. The transportation in the urban and suburban areas is served conveniently by jeepneys and taxicabs.

As the capital of the Province, Iloilo City is the location of many governmental institutions. Further, its long history since the Spanish regime has made the city a cultural center in the Philippines. The scores of government offices and stations, which were visited by the present survey team, are listed in the introductory notes of the report.

Iloilo City, as a center of culture, is unique especially in its highly developed educational system. The schools from primary to college and university level number at least 50, and the existence of 11 college grade schools in the city cannot be witnessed in any other city of the same size within the country. The schools are attended by many students who come from other islands. The Catholic churches, large and small, are ever present in the cityscape.

With regard to establishments and institutions related to the fishery industry, there are a half-dozen cold-storage and ice-plants, where the fish harvested in ponds and those fished in the surrounding seas are collected and treated, and a great amount of the products is shipped to Manila, the nation's largest consumer center.
One of the cold-storage plant is equipped with a freezing system and produces frozen shrimp for export abroad. The central market in the city operates 365 days a year and and handles fresh fish and dried fish products both in wholesale and retail systems. The market provides a convenient place where specimens of fish, shrimps, crabs and other sea organisms are easily available.

The convenience and standard of living in Iloilo City can be judged from various viewpoints, and some of the information gained by the members of the survey team may be given as the sources for the judgment. There are 12 banks, more than 5 hospitals, 7 post-offices, 4 or 5 hotels (operated on international standards), scores of restaurants, etc. The living expenses are believed to be quite reasonable ; meals are served at a cost 1/2 to 3/5 that paid in Japan; house rent is estimated to amount to 1/4 that charged in Japan; hotels of the first class charge US$7.00 for a single air-conditioned room. The jeepney and taxicab can be hired at very low cost. The English language is spoken in most places in the city.

3 Geography and Climatic Condition in the Region

The site is located 15 km east of Iloilo City on the southern coast of Panay Island, and faces Guimaras Island across the 5 km Iloilo Strait. Concrete-asphalt national highway (No. 2) runs from Iloilo City to the town of Leganes (10 km), from where a half-paved road leads to the site of Fish Culture Station (5 km), the road ending at a wooden bridge over the Gui-gui Creek. The road running from the bridge along the northern side of the site is not paved but will be improved to a reinforced road by the local government, which will also reconstruct of present wooden bridge over the creek. The site of the station can be reached by car in 30 minutes from Iloilo City; it can be also reached by boat from the same city.

The site of the station (Fig. 4) which was leased by the Leganes Municipality is about 50 ha in area: It is shaped roughly in the form of a rectangle which is bent slightly near its middle and extends from southwest to northeast. The rectangular area measures approximately 1,250 m in length and 260 m in width. The site and its surrounding land have been used either as fish ponds for culture of milkfish or salt drying tanks. Fig. 2 and 4 and Photo. 1 explain the extensive development of the construction work.

The topography of the region where the site is located is a flat plain slightly declined toward the shore line which is protected by mangrove trees or low dikes constructed by coral blocks. Gui-gui Creek, which extends from the sea landward for a distance of about one km, washes the southwest boundary of the site; the creek is about 50 m in width with a depth of a little over one meter, and its bottom is muddy at the site. The Jalaud River, one of the long streams in Panay Island running for a distance over 95 km., approaches the northern periphery of the site with a road constructed on the river bank as a barrier; the flow of the river is about 120 m wide at the site and is 20 to 200 cm deep (Fig. 8); the bottom is sandy. The shore sea water in the region is shallow, measuring only one meter or so even one km off the present shore line. According to the local fish culturists, the coastal water in the region will in near future be reclaimed into fish ponds covering an area of 100 to 200 ha. The fish ponds and salt drying tanks developed in the region lead the waters needed for their operation from either the Jalaud River or Gui-gui Creek or directly from the sea.

The whole area where fish ponds or tanks are developed does not have a growth of high trees or plant communities other than the low growth of bushes scattered here and there on or along the dikes and banks. The human community observed nearest to the site is about 10 farm house holds standing on the bank of the Jalaud River. (Photo. 2, top).

The nature of the soil in the general area of Iloilo City is, as quoted from the data of the Bureau of Soils, Iloilo Province, as follows. "The formation and origin of

the land is recent alluvial deposits. In profile the surface soil (25 to 30 cm) is black to dark brown in color; moderate coarse, granular and highly plastic clay. The subsurface soil (30 to 79 cm) is lighter in color than the surface; it is moderately granular and highly plastic clay; lower subsurface soil is silty clay,. brownish to light brown in color. The substratum in the profile is brown silt loam, friable and good fine granular without stones or gravels. The relief is level lowland, where the drainage conditions are fair to poor."

Referring to the nature of the bottom soil in fish ponds, the Philippine Research Society for Fish Culture, Iloilo City, describes it as follows. "Soil conditions of the fish ponds in Iloilo Province are diverse ranging from silty loam to pasty clay and sandy loam, and from very high producing to practically sterile ones. These types may be found within a radius of 30 km from the site. Researchers and students may be able to undertake studies under these various conditions without having to go far."

The character of the soil is deeply related to the productivity of fish and the building of ponds. The present survey team was led to believe, from visiual observation of the site and information obtained, that the soil at the site is clayish enough for the general construction of ponds. The fertility of the soil at the site, as explained by local fish culturists, is by no means high, and fertilizer (nitrogen source) must be applied to expect a good harvest of fish. A chemical analysis of the pond soil taken at the Bureau of Soils, Iloilo, also indicates a low content of nitrogeneous elements.

The climatic conditions in Iloilo Province (Leganes included) were explained by the Weather Station, Iloilo City, in few words but precisely, as follows. "The climate is divided into two seasons: dry from February to April and wet during the rest of the year with a maximum rain period from June to October. The dry season coincides with the northeast monsoon, and during the maximum rain period the southwest monsoon prevails. This may be explained by the fact that air coming from the northeast during the prevalence of northeast monsoon is considerably dried crossing the high mountains of the Bicol regions, Samar, Leyte and to a smaller extent those in Masbate. Therefore little rain is left available to Iloilo. On the other hand, the southwest monsoon brings with it moist air which is capable of giving off much rain. These facts are supported by the climatological data computed for the region. Based on a 47-year period for the region, March is the driest month with an average rainfall of 3.5 mm ; February and April are nearly dry with a monthly rainfall average of 4 and 4.9 mm, respectively; July is the wettest month with an average rainfall of 40 mm; June, August, September and October averages above the 25 mm mark."

In temperature the region is just average in the country. Its mean annual tempertaure of 27. 0°C is only 0. 2°C degree higher than that computed for the entire Philippines. January is the coolest month with a mean temperature of 25. 8°C; from that month the temperature rises to a maximum in May with a mean of 28.3°C, then drops gradually until September when it rises again to a secondary maximum; then it steadily decreases to a minimum in January (Fig. 3).

The region is not as frequently affected by tropical cyclones as most of the other places in the Philippines, and for a period of 32 years only 12 strong typhoons passed.

The general climatic conditions at the site can be also understood by the diagrams presented in Fig. 3, which was prepared based on the data of the Weather Station, Iloilo. The climate in this area in the Philippines is believed much more favorable for living than other places along the coast in the country. The most significant fact in the climatic conditions in the region is the nearly complete absence of typhoons as noted above. This fact is reflected clearly by the absence of construction on the shore line to protect the ponds and houses developed on land side. In the designing and

building of fish ponds in this region, the absence of typhoons saves extra consideration in the construction of ponds and extra expenses. The other climatic factors such as rainfall, wind and temperature are intimately related to fish culture practice, fishing operation on the sea and the ecology of fish and shrimp. These problems will be taken up in the paragraphs dealing with these respective subjects in the present report.

4 Sources of Waters at Leganes, Quantity and Quality

It is of paramount importance to have an exact knowledge on the tidal change of the sea-water both for the designing and operation of brackish water fish ponds. This is usually gained from the tide-table. Since no adequate table for the Leganes coast is available, it was found necessary to seek other sources for the purpose. Provided with the Admiralty Tide Tables, London, at hand which records the data for Cebu, Standard Port, a conventional method to transfer the readings at Cebu to Leganes was followed. It is explained below.

Table 2. Result of hydrological survey on March 26, 1971, in the Gui-gui Creek, (Station A, B and C), coastal sea (Stations 1 to 10) and the Jalaud River (Station E, F and G). The data for the creek and coastal sea are plotted on the map (Fig.11). Station E is on the mouth of the river, F about 2 km upstream and G about 2.5 km upstream. The depth of water is shown based on the datum level fixed or the M.L.L.W. of the Leganes coast.

Station	Time (hr)	Air	Temperature (^{o}C) Water		Trans-parency (m)	Depth (m)	Salinity (o/oo)	
			Surface	Bottom			Surface	Bottom
Sea: 1	0918	28.0	26.3	26.4	1.30	-0.13	32.4	32.6
2	0935	27.1	26.3	26.2	1.40	-0.70	33.6	32.5
3	0947	26.7	26.4	-	-	+0.39	32.4	-
4	0956	27.2	26.5	26.3	1.10	+0.30	31.8	32.4
5	1006	27.6	26.6	26.8	2.00	-0.82	29.8	31.8
6	1018	27.8	26.8	26.6	1.00	-0.16	32.5	32.8
7	1033	27.4	26.7	26.6	1.4	-0.105	32.7	32.3
8	1045	27.5	26.4	26.5	1.30	-0.475	32.4	32.6
9	1054	27.8	26.6	26.4	1.30	-0.46	31.8	32.5
10	1109	28.6	26.7	26.7	1.40	-0.89	31.8	32.7
Creek:								
A	1239	26.8	25.9	25.5	1.30	-1.70	31.7	33.6
B	1254	26.8	26.1	25.9	1.30	-1.23	31.7	32.3
C	1301	25.0	26.4	26.3	1.30	-1.09	31.7	32.4
River:								
E	1325	25.0	26.7	26.6[1]	1.10	-0.80	30.5	32.8
F	1355	-	26.8	26.1[2]	1.00	-0.279	3	3
G	1512	26.6	26.2	26.2	0.80	-0.13	3	3

1 Value to waters from 1 to 3 m deep.
2 Value to waters from 1m to bottom.
3 At Station F, surface 9.0, 1 m deep 11.5, 2 m deep 15.7 and 3 m deep 15.7; At Station G, surface 4.3, 1 m deep 4.3 and bottom 3.5.

The 12-hour checking of the water levels in Gui-gui Creek (Fig. 5) shows the differences between Cebu and Leganes coast as follows (these figures might be modified by additional observations in future) : Time difference + 11 minutes at high water and + 52 minutes at low water ; ratio of the tidal range 1.29 ; mean sea level + 10 cm ; monthly changes of mean sea level from January to December, -6, -9, -6, -3, 0, +3, +3, +6, +6, +6, +3, -3 cm, respectively. These differences bring up the tidal specificity at Leganes gainst Cebu as follows : Cebu 207 and Leganes 252 cm for the highest astronomical tide (H.A.T.) ; in the same way, 152 and 181 cm for the mean higher high water (M.H.H.W.), 91 and 102 cm for the mean lower high water, 73 and 79 cm for the mean sea level (M.S.L.), 43 and 40 cm for the mean higher low water (M.H.L.W.), 12 and 0 cm for the mean lower low water (M.L.L.W), and 52 and -81 cm for the lowest astronomical tide (L.A.T.), where the datum level (D.L.) at Leganes is placed on the M.L.L.W.

A linear curve drawn in Fig. 5 is the calculated tidal change and the range for Leganes coast converted from the data at Cebu by using those constants given in the preceding paragraph. For the calculation it might be mentioned that the height of tide between low and high water was determined from the graph (Fig.6) appended. Attention is called to the same figure (Fig. 5) for the range of bottom levels which were measured in several ponds near BM 1 on the Jalaud River side. It is apparent that these ponds are allowed to take in water from an extremely limited range of tide.

The two Bench Marks, Bm 1 and 2 (Fig. 4) established on river side and creek side, respectively, are leveled 332 and 171 cm from the M.L.L.W. or D.L. defined above. It may be noted that since BM 2 on the creek side is a marking painted on the trunk of a mangrove tree, it should be changed to a permanent construction like the concrete-made block of BM 1.

It is clearly understood that the position and level of BM 1 on the river side will be the definite and solid basis horizontally and vertically for any kind of survey attempted on the site.

The another source of the pond water for the station is the Jalaud River. The fluctuation of the water level must be clearly understood as in the case of sea water. A mathematical procedure which was used for a similar river in Japan was adopted, and it is introduced herewith.

The fluctuation of the water level within the range of tidal effect or tidal compartment is responsive to 3 variables, the tidal change at the mouth of river, the tidal period and the amount of flow. The 3 factors work jointly to affect the water levels, but a mathematical test attempted by means of an electronic computer derived the relations of these factors as expressed in the formulas given below (authorized by Dr. M. Nakamura) :

$$\Delta H = f_1 (q_B) + \left(K \quad \frac{\mathcal{S}_o}{gT^2} , \quad \frac{S}{AC} \right) \qquad (1)$$

$$\frac{\mathcal{S}_R}{\mathcal{S}_o} = f_2 \left(\frac{\mathcal{S}_o}{gT^2} , \quad \frac{S}{AC} \right) \qquad (2)$$

$$\frac{\Delta T}{T} = f_s \left(\frac{\mathcal{S}_o}{gT^2} , \quad \frac{S}{AC} \right) \qquad (3)$$

where : q_B is Base flow discharge of river; A, Cross-section of river ; S, Equivalent surface area of tidal compartment ; C, Coefficient of flow between the station and the river mouth; g, Acceleration of gravity (=9.8m/S^2); ΔH, Difference of water head between the station and the river mouth; ΔT, Difference of tidal period between the station and the river mouth; ζR , ζO, Tidal range at the station and the river mouth, respectively; T, Tidal period.

In the process of solving the above formulas, firstly the data taken from the 12-hour continuous observation are tabulated as :

ΔT	ΔT (minute) mean	T Hour : Minute	ζR	ζo (cm)
L.W. 34				
H.W. 14	24	10:52	172.5	174.5
L.W. 30	22	14:08	182.0	183.5

In the basis of the data above, the value S/AC = 1.74 x 10^4, and with this value, the relation of formulas (2) and (3) is expressed graphically (Fig. 7). Then, with the tidal level at the Leganes coast which is known already, $\zeta o/_g T^2$ is obtained ; from the curves in Fig. 7, ζ_R and ΔT are available.

The next step is to express formula (1) on the graph. Firstly, A = 126 x 1.4 = 172 m^2 is gained from the cross-section of the flow (Fig.8). On the other hand, formula (1) is expressed approximately as :

$$\Delta H = \frac{n^2 L}{R^{4/3} A^2} q^2 + K\left(\frac{\zeta o}{gT^2}, \frac{S}{AC}\right) \qquad (4)$$

where, n is roughness coefficient by manning; L, distance from the station site to the mouth of river; R, hydraulic radius (close to the depth). In the present case, L = 2,500 m, and R = 1.4 m (see Fig. 8). Since, the magnitude of mean water level due to tide or $K\left(\frac{\zeta o}{gT^2}, \frac{S}{AC}\right)$, and the roughness coefficient (n) are available from the data of actual observation, and since the value of S/AC, as explained before, is constant to the river and calculated 1.74 x 10^4, it is deducted that:

$$K\left(\frac{\zeta o}{gT^2}, \frac{S}{AC}\right) = K\left(\frac{\zeta o}{gT^2}\right)$$

It is held that $K\left(\frac{\zeta o}{gT^2}\right)$ must be gained from actual observation under varied $\zeta o/_g T^2$, and the value of n will be measured correctly during the rainy season. Holding that K is available and H = 0.07 m on the cross-section of the flow (Fig.5), and making n = 0.02 as applied in usual cases, formula (4) above will be caluculated as ;

$$\Delta H = 2.5 \times 10^{-5} q^2 + 0.065 \qquad (5)$$

which is presented graphically in Fig. 9.

It is concluded that the level of the Jalaud River water at the station site can be calculated based on the tidal change of the Leganes coast based on the mathematical

graphs which are derived from the process introduced above (Figs. 7 and 9). The process of the calculation, then, can be explained by taking two cases as examples.

The result of the 12-hour continuous observation of Gui-gui Creek (Fig. 5) provides the data as tabulated below :

Time (Hours)	W.L. (cm)	ζ_o (cm)	Time (hour : minute)	Case
0610	- 91.0			
		174.5	5.26 x 2 = 10:52	I
1136	83.5			
		183.5	7.04 x 2 = 14:08	II
1840	-100.0			

Herein, $\frac{\zeta_o}{gT^2} = \frac{1.745}{9.8 \times (65.2 \times 60)^2} = 1.16 \times 10^{-10}$ for case I, and for case II it is $\frac{1.835}{9.8 \times (848 \times 60)^2} = 7.24 \times 10^{-11}$. From the graph in Fig. 7 it is obtained that ζ_R = 169.1 cm and ΔT = 25 minutes for case I, and for case II ζ_R = 181.0 cm and ΔT = 21 minutes; from the graph in Fig. 9, it is found that ΔH = 7.1 cm, where q = 3 m^3 / sec. is held. The answer, levels of the Jalaud River water at the station site for given times, is shown in table below :

Time (hour : minute)	Water level (cm)
06:10 + 00:25 = 06:35	$-91 \times \frac{169.1}{174.5} + 7.1 + 73 = -8.1$
$11:36 + \frac{25 + 21}{2} = 11:59$	$83.5 \times \frac{169.1 + 181.0}{174.5 + 183.5} + 7.1 + 73 = 161.7$
18:40 + 21 = 19:01	$-100.0 \times \frac{181}{183.5} + 7.1 + 73 = -18.5$

The water levels thus calculated are plotted against the levels actually observed in Fig. 10, where the levels between high and low tide were filled up by using the graph in Fig. 6. It is commented that some disparity was found between the calculated and observed levels in falling tide. This is believed attributable to the nature of the graph above, which is designed for the tidal change of the sea water but not for the water in the tidal compartment of river.

The qualities of the waters in the region were studied with reference to temperature, salinity and turbidity (by the Secchi Disk reading). And the survey for these subjects was conducted on March 26, in addition to the 12-hour observation, on Gui-gui Creek, the Jalaud River and the immediate shore water off the mouth of creek. The result of the survey is presented in Table 2 and illustrated in Fig. 11. Needless to mention, the qualities of the waters studied during the present survey carried out in dry season signify the features of this climatic condition. The different features of these conditions, which are expected to occur in the rainy season, must be also made clear in comparison.

Gui-gui Creek is said to have developed as the result of natural erosion of many years. Thus, it should be understood that the present configuration may not be kept unchanged. The creek is about 50 m wide (Photo. 3) at the station site, and the water penetrates some 1,000 m into the land; it is bordered in its entire course by fish ponds and salt tanks. Since the creek is not fed by freshwater in any appreciable

amount, except perhaps rain water, the general hydrological characters are almost equivalent to the sea water outside. This is well reflected in the salinity and transparency (Fig. 11). In this respect, however, it may be pointed out that the salinity of the creek water shows a tendency to become lower in high tide than in the low (Fig. 12). This fact, not fully understandable at this moment, will require further studies.

Table 3. Records of the 12-hour continuous observations on the level, tempereture and salinity of water conducted on March 27, 1971. The stations of the observations are located to the BM 1 and BM2 (see Fig.4). The data are shown graphically in Figs. 5, 10 and 12.

Gui-gui Creek					Jalaud River				
Time (hr)	Level (cm)	Temperature(°C) Water	Air	Salinity (o/oo)	Time (hr)	Level (cm)	Temperature(°C) Water	Air	Salinity (o/oo)
0610	11.0	23.5	-	35.8	0600	25.0	24.4	23.4	1.5
0640	12.5	23.4	23.9	33.8	0630	20.0	25.3	22.9	1.2
0710	16.5	23.6	24.6	33.7	0700	20.0	25.6	25.5	0.2
0740	31.0	23.9	26.4	33.9	0730	26.0	25.8	24.5	0.2
0810	51.5	24.4	25.5	32.5	0800	39.0	25.8	24.4	0.2
0840	73.0	25.3	26.9	32.1	0830	56.0	26.0	26.1	0.2
0910	98.0	25.7	27.9	33.5	0900	80.0	26.2	28.2	0.2
0940	126.5	26.5	28.4	32.2	0930	106.0	26.3	27.8	0.2
1010	149.0	26.8	28.7	32.2	1000	136.0	26.3	28.1	3.6
1040	166.0	27.4	29.4	32.3	1030	161.0	26.6	28.9	14.2
1100	174.5	27.3	29.1	31.9	1100	176.0	26.6	29.8	22.1
1110	180.5	27.2	-	32.2	1110	183.0	26.7	29.8	25.4
1120	184.0	27.3	-	32.2	1120	186.0	26.8	29.8	29.3
1130	184.0	27.2	-	31.8	1130	189.0	26.8	29.7	29.3
1140	185.0	27.5	29.3	32.9	1140	191.0	27.0	29.9	30.0
1150	184.0	27.3	-	31.6	1150	192.0	27.1	30.6	30.1
1200	182.0	27.3	-	32.3	1200	191.0	27.2	29.6	30.8
1210	178.5	27.4	30.1	32.3	1230	182.0	27.4	29.5	30.1
1240	169.0	27.5	29.6	31.6	1300	169.0	27.4	29.3	14.2
1310	154.5	27.8	29.8	32.3	1330	140.0	27.3	30.3	9.6
1340	132.5	27.8	28.5	32.9	1400	134.0	27.2	29.4	9.6
1410	117.5	28.7	30.0	32.4	1430	117.0	27.3	29.5	23.5
1440	89.0	28.9	29.9	33.6	1500	98.0	27.1	28.8	21.4
1510	81.5	28.8	28.8	32.3	1530	82.0	27.2	28.8	20.2
1540β	62.0	28.7	28.8	32.3	1600	65.0	27.1	27.6	17.5
1610	47.0	28.4	28.5	32.3	1630	54.0	27.0	27.8	15.5
1640	31.0	28.0	28.2	32.3	1700	40.0	27.0	27.8	0.2
1710	18.0	27.7	28.0	32.9	1720	31.0	27.1	26.3	0.2
1720	15.0	27.7	28.0	34.3	1730	29.0	27.1	26.3	0.2
1730	11.0	27.6	27.8	35.0	1740	26.0	26.8	27.1	0.2
1740	8.5	27.3	27.5	34.9	1750	23.0	27.0	26.9	0.2
1750	6.0	27.4	27.1	34.9	1800	20.0	27.1	26.9	0.2
1800	4.0	27.1	27.2	35.5	1810	17.0	27.0	26.9	0.2
1810	3.0	27.4	27.3	36.9	1820	15.0	27.1	26.8	0.2
1820	3.0	26.8	26.9	36.2	1830	15.0	27.0	26.9	0.2
1830	2.0	26.5	-	36.2	1840	13.0	26.8	26.5	0.2
1840	2.0	26.9	-	36.8	1850	11.0	26.5	26.1	0.2
1850	1.0	27.0	-	38.9	1900	10.0	26.5	26.3	0.2
1900	2.0	27.1	-	38.9	1910	10.0	26.5	26.0	0.2
1910	3.5	26.7	26.5	38.9	1920	10.0	26.7	26.0	0.2
1914	5.0	-	-	-	1930	13.0	26.6	26.6	0.2

The turbid water of the creek which is shown by its low transparency (around 130 cm) will prove its inferior quality as the source of the tank water in which larval shrimps are to be reared or kept. The appraisal of the water as the medium for rearing shrimp larve, of course, may not be made under a simple term in the manner stated above. The judgement given above was reached based on the rules of experience on Penaeus japonicus, but not of P. monodon. However, under the present level of biological knowledge and the status of tank rearing of shrimp larva (see the chapter dealing with the problems in the presnet report), the judgment reached will not be withdrawn unless evidence will be shown to the contrary.

The immediate shore water in front of the site is shallow for a considerable distance; the midportion of Iloilo Strait (4 km to Gimaras Island) is less than 20 m deep. A shallow mudbank extends more than 1,000 m from the shore line (Fig. 11), and the bank will be dried up over a vast area at spring low tide. The turbid water here (Table 2), similar to Gui-gui Creek, appears without question to be unsuitable for the rearing of shrimp larvae. The turbid water in Iloilo Strait was also observed in the area between Iloilo City and Guimaras Island and westward to Oton. It is easily predicted that the turbidity in the region will further increase with incoming rainfall during the wet season.

In contrast to the turbid water in the region, the shore waters extending westward from Oton were observed to be clearer, which was plainly shown by the Secchi Disk readings at Miagao, San Joaquin and Tialas (April 1, 1971).

The Jalaud River is one of the largest in Panay Island with its main flow extending nearly 100 km from its head in the north of the Iloilo Plain to the mouth ending in a delta. In the drainage of the river the clutivation of rice and sugar-cane developed in vast area with a net-work of irrigation systems connected to the river.

The river at the station site, about 2.5 km upstream from the sea, is some 100 m wide, with the bottom partly muddy and partly sandy (Fig. 8 and Photo. 4). Since the tidal compartment of the river is estimated (by visual observation) to extend 6.5 km, the flow at the site of station is completely replaced by sea water in high tide. The salinity of the river water at the site, because of its position in the compartment, changes from nealy 0 to 30 o/oo(Fig. 12). In this connection it is noted that the change in salinity takes place abruptly both in rising and falling tide, suggesting that the stratification ocurrs to a considerable extent. The water mass with layers of different salinity, without breaking the layers, moves up and down in river with tidal fluctuation. This fact is believed favorable for the supply of "freshwater" to fish ponds if so desired. Further, the amount of available freshwater will increase with the rainfall during the wet season.

How the salinity of the water affects to the growth of milkfish, shrimp and other organisms is a problem highly significant to the practice of culture in brackish water ponds. The correct answers to the problems will need a series of experiments conducted in the waters of different salinities. Accordingly, the waters available from the Jalaud River will play an important role in the experiments conducted at the station.

The fears of pollution of waters in the region, though not investigated with particular emphasis, were observed to be not so serious for the operation of the station, at least for some time to come. It may be mentioned in this respect that the danger of water pollution, if threatened, will have to be borne by every fish pond extensively developed in the region, because all of these ponds depend on the same sources of waters.

The town of appreciable size developed nearest to the site is Iloilo City. The water flows in the city, the Iloilo and Jaro Rivers and associated streams and creeks, are all connected either directly or indirectly to fish ponds or salt tanks (Fig.2). This fact explains the cleanliness of these waters. The waters in the downtown areas were observed to be not necessarily clean in view of sanitation, but no signs of menace were seen. These waters are all exposed to tidal change day to day. The observations on the urban development, including port facilities and the water flows as commented above, lead to the belief that there are no signs of danger of urban pollutions in the areas including the station site at Leganes.

The sea water in Gui-gui Creek carries no signs of any danger of water pollution, because of the fact that the creek is completely surrounded by fish ponds and salt tanks.

The Jalaud River, as mentioned already, runs in the vast land areas of agricultural operations, and the irrigation system in the areas is mostly constructed with passages to the Jalaud River. The present status as such will naturally create the fear of the water pollution originating from the use of agricultural chemicals (insecticides, pesticides, etc.). However, it may be stated at the present moment that the problems are intermixed with various factors - technical, social and administrative, and the solutions of the problems will not be reached merely from the viewpoint of fish culture circles alone. It is hoped that the Jalaud River Development Project, a government program, will draw serious attention to the issue for the benefit of all the people in the region.

The sugar-cane refineries operating in the drainage of the Jalaud River are believed to carry potential danger of polluing the river water. One refinery, inspected by the survey team (April 2), is located along the river about 40 km upstream, and the two others are farther up (over 80 km) in the same drainage. The effluents from these plants eventually reach the station site down below. The present scope of the operation at the refinery was observed to be not large enough to create danger in the immediate future. But, its possiblility should be watched with utmost care.

5 Fish Pond

All the fish ponds constructed on the site and adjoining areas have been used for the culture of milkfish (Photo. 2). Shrimps are harvested from the same ponds as incidental crops. At the time of the present survey, mid-March to early April, most of these ponds were dried up; some of them were being refitted (Photo. 6), and others were being treated by fertilizers. In the region there were some new ponds under construction, and those existing were waiting for new water.

The majority of the ponds in the region (Photo. 6) are constructed to keep the water less than 50 cm deep, and the surface area varies from 1 ha or less to 10 ha and more. The levels of the bottom and water canals, of which some were surveyed (Fig. 5), were observed to be quite high as regards the tide level of the sea and river. Irregularity is the general rule with regard to the shape of the ponds. The dikes surrounding the ponds or water canals are built in the simplest way None of the dikes and banks in the region were observed to be wide and strong enough to permit the passage of motor vehicles. The water gates are the type using flash-boards in most cases. They are wooden-made, except those attached to the main canal (Photo. 5), which are concrete. The screens are made from split bamboos or similar materials .

It was observed in general that the design of the ponds and other associated construction must have been made on the basis of local customs and traditions. Furthermore the management of pond water, whether in feeding or draining, was appararently planned and practiced within the limit of experiences gained in the past. It seems very clear that the management of water developed locally has not been practiced so as to utilize the potential energy of the sea water to the fullest possible extent. The studies and improvement of these subjects will be a part of the important tasks assigned to the station.

The production of milkfish in ponds, though not investigated in the present survey, is ranked in the first class within Iloilo Province (see Chapter dealing with Panay Island). Within the region of the station site (Fig.4), it was informed that the ponds located closer to the shore line produced more fish than those constructed farther up from the shore. This fact, if true, will require careful examination.

Of the extraneous fishes in the milkfish ponds, most of them were claimed to be either predators on or food competitors to milkfish. The present survey was limited to the collection of specimens in the ponds (March 20, 21 and 24). The fishes identified (by Dr. T. Kafuku) were as follows : Elops hawaiiensis, Megalops cyprinoides, Therapon jarbua, Anabas testudineus, Glossogobius giuris, Hemiramphus sp., Leiognathus insidiator, Mugil spp., Scatophagus argus, Gerres sp, Eleutheronema tetraodactylum, Gambusia sp. and Tilapia mossambica. Among these, the tilapia was found most abundant in the ponds of this region; a single collection made from a collection made from a collecting pool (April 26) counted 29 mosquito-fish, 22 climbing-perch and 139 tilapia of 3 to 15 cm long. The prolific population of the tilapia in the ponds was also endorsed by the discovery of spawning-nests crowded on the dried-up bottom of a pond in the station site (Photo. 7). It was also observed that all the ponds in the region were inhabited by sea-snail (Cerithidea spp.) of immense association (Photo.8).

6 Shrimp and Its Culture

During stay in the Philippines (Luzon, Panay and Mindanao Islands) the present survey team was able to collect some information on the biology of shrimp and the status of its production in fish ponds. The information included collection of the samples at the market and in the field, visual observations of the actual sites, and conversations with biologists, fish culturists and fishermen. Though quite fragmentary and a patchy, the information and materials thus obtained are believed to serve at least in a certain extent in the planning of the works contemplated at Leganes Station.

It should be recorded here that the successful experiments on the cultivation of shrimp larvae (Penaeus monodon) in tanks carried out at Naawan, Mindanao Island, by the biologists of Mindanao State University are not only the most valuable information assembled but also will undoubtedly mean the starting point for shrimp culture in the Philippines.

The species: The commonest species of shrimp is Penaeus monodon, known as "sungpo" in the Philippines, which is widely found in the market and in the field. In the cultivation of shrimp in ponds the "sungpo" appears to be one of the most suitable species. It is popular among fish culturists and fishermen as well as the general public throughout the country, and the fisheries officials and scientists have directed their works mainly to this species among the many other forms.

The species of shrimp commonly found in the ponds (of milkfish culture) include several others in addition to "sungpo", as noted below. According to one published information there are 507 species of crustacean decapods recorded from Philippine waters, but the species of penaeid shrimp, the most suitable for cultivation in brackish-water ponds, have not yet been studied as to its taxonomy and other biological characters.

In this connection a collection of specimens conducted at the market in Iloilo City (March 1971) is recorded below. The species, identified by Drs. T. Miyake and T. Fujino, Kyushu University, and the number of specimens collected for each species are : Penaeus indicus (1 male and 1 female), P. japonicus (2 females), P. latisulcatus (3 males and 6 females), P. merguiensis (13 males and 14 females), P. semisulcatus (6 males and 5 females), Trachypeneus grannurosus (29 females), T. sedili (1 female), Metapenaeus ensis (39 males and 67 females), M. intermedius (3 females) and Metapenaeopsis barbeensis (3 males and 6 females). It is not known, of course, whether these market specimens come from sea water or pond water. It may be mentioned that a few samples gained in milkfish ponds at Leganes (March 1971) were identified as P. merguiensis and M. ensis. These two species were found, incidentally, to be very common (see above) in market.

The fresh water palaemonid shrimp, represented by Macrobranium rosenbergi which is found throughout the country, has also been remarked for its culture in ponds. It was confirmed that the species is common in the creeks of low salinity running criscross around the station site in Leganes Municipality.

The same collection made at Iloilo market (March 1971) also included two species of crabs, Portunus pelagicus (6 males and 2 females) and Veruna litterata (1 male). It is added that the so-called mud-crab (Scylla serrata), though not collected at the time, is the most valuable edible crustacean in the country, and fetches a high price. The development of techniques to culture this crab in brackishwater ponds will bear high significance.

Ecology of the gravid females and fry shrimp : The information on the ecological characters of the shrimp was obtained mainly on the "sungpo" or Penaeus monodon because of its high value as a pond culture species. And the major part of the information was naturally sought on the occurrence in the nature of the mature females and the fry.

In the highest elaboration this information was obtained at the Marine Research Laboratory, Mindanao State University, Naawan, and by the biologists working there. The findings and experiences on these subjects introduced below were quoted from their verbal presentation delivered at the Laboratory (Photo.10).

Panguil Bay, a narrow inlet penetrating some 35 km between the two Provinces, Misami Occidental and Lanao Del Norte, is a shallow water less than 10 m deep with a muddy bottom. The inlet is the nursery ground for several species of shrimp including Penaeus monodon, P. japonicus and P. indicus, which spend their juvenile stage there. With the progress of their growth these species migrate northward and into deeper water to the mouth of the inlet or southern end of Iligan Bay, and open water. These species of shrimp find their spawning ground in this region, as evidenced by finding more mature females there than in others. It was mentioned that both in nursery and spawning grounds the sandy (or more sandy) bottom is frequented more by P. japonicus than P. monodon and P. indicus, the latter two preferring a muddy bottom.

The shrimp fry in this region are found in the waters of beach and rivers and creeks flowing into Panguil Bay and Iligan Bay extending north to Iligan City; the population of the fry is denser along the estern than the western coast of Iligan Bay. The shrimp fry (postlarvae and juveniles) are collected by means of dip-net without much difficulty. The collections include the fry of different species of shrimp, but P. monodon is distinguished by its size and coloration by experienced fishermen.

The spawning of the shrimp seems to take place throughout year, with the peak during the wet season starting from November and lasting to February the following year. The fact is evidenced by the relative abundance of mature females in the population. The appearance of the fry is also witnessed nearly corresponding to the spawning season.

The behavioristic characters of both adult and young shrimp are easily observed corresponding to local climatic conditions. The northward migration of the shrimp takes place in the months of June to October when the southwest monsoon prevails and the simultaneous rainfall lowers the salinity of the sea water, a fact which might play a role in accelerating the development of gonad. The larval shrimp hatched during November to February may be carried southward by the northwest (to north) monsoon during this period.

In this region in Mindanao Island the gravid females are collected most effectively by commercial gill-netting operation. The gear, bottom gill-net commonly used here measures one meter high and 100 m long with a stretched mesh size of 2.5 cm. During the peak spawning months a single operation (using 4 to 6 sets) results in one mature shrimp in each set; one operation takes one hour, and two operations are made a day at 0600 and 1700 hours. The gravid females unfastened from the mesh are kept alive in a container holding sea water sufficient to cover the shrimp, and brought back harbor.

The small otter-trawl operated by 3-ton fishing boats also catches mature females in the same waters as gill-net fishing. The main catch of the trawling consists of lizard-fish, flat-fish and slipmouth, and during peak spawning months a single hauling usually taking one hour catches 10 to 20 gravid females. Fish corrals in this region are operated in the waters 5 to 9 m deep and 100 to 200 m offshore. But the gear seldom trap gravid females.

A small amount of information concerining gravid shrimp females was also collected at a small fishing community in Miagao Municipality, on the southern coast of Panay Island (Fig. 1). Interviews with a few fishermen in the community resulted in information noted below. One type of beach seine, locally known as "sahid", catches mature females of P. mondon or "sungpo" from May to September when seaward wind prevails and the operation of the gear is practicable. One example of the "sahid" measures 5.4 m long and 1.2 m wide at the mouth; the pulling rope on each side is 50 m long; the net is placed in water 10-12 m deep and 20 m offshore, and pulled to the beach by ropes.

It is presumed that the occurrence of the gravid females in the waters so close to the beach is due to the sudden drop of the sea bottom along the beach in this region. Marine charts indicate that depths of 40 m approaches only 200 m from the shore line. It is understandable therefore that the sea water on the beach is much clearer compared to that in Leganes; the Secchi disc readings in this beach was more than 4 m.

Along the southern shore of Panay Island from the Leganes region westward to Oton, it is generally stated that shrimp fry are abundant during the wet season (June to October). Also they seem to enter the streams and creeks which have some

unknown conditions and/or factors.

According to a milkfish culturist in Dumangas, the creeks surrounding his ponds hold millions of fry during the rainy season. Experienced fish culturists of Iloilo City speak of abundant shoals of shrimp fry dwelling in beach waters extending westward to Oton. Also, in many creeks in the region there are found millions of fry during the wet season. Especially in the Batiano River, which runs paralled with and close to the shore line, the fry abound during the rainy season. These shrimp larvae and juveniles are trapped by small weirs established across the flow (Photo. 9).

Shrimp culture : It is no exaggeration to state that in the Philippines the culture, in strict sense, of shrimp has not been developed despite the extensive culture of milkfish as a valuable fishery industry. The shrimp is harvested in the same ponds with milkfish, but it is merely a byproduct from the pond. The young shrimp flow into the pond with the sea water when the gate is opened, and they grow larger in the pond. They feed on miscellaneous organisms growing in the water and on bottom soil.

The fish culturists engaged in milkfish cultivation, it is observed, are eager to start the culture of shrimp in their milkfish ponds on a commercial basis. But it was felt that the lack of techniques has been obstructing this practice. Apparently these people have not started the work at great risk. Experimental operations have been attempted by some of the culturists in recent years by stocking shrimp fry in their ponds, but the results were so variable from one time to another that they lost confidence and interest in the work. One milkfish farmer in Iloilo City complained the survival rate of the shrimp varied from 0 to 80% against the number of stocking, while another operator in Manila City experienced a survival rate of 200 % !

Rearing of larval shrimp in tanks : Stocking of the fry into the ponds is the first step to be taken in the process of shrimp culture. There are two practical methods to obtain large numbers of the fry : the collection or catching of the fry in natural bodies of waters, and the rearing of the larvae in tanks to postlarval stage or juveniles. A biological technique of the latter method has been developed in Japan for local species, Penaeus japonicus, and in a number of countries in the world, shrimp biologists, often adopting Japanese technique, have attempted to develop a similar method for their native species of shrimp.

In the Philippines the tank-rearing of P. monodon was conducted with success, as pointed out previously, by the biologists of Mindanao State University Marine Research Laboratory, Naawan. The Philippine Fisheries Commission with the same intention started 4 years ago the work at Mercedes, San Miguel Bay, southern Luzon Island. A so called shrimp Hatchery Station was established. The main construction in the Station, according to a reliable source, includes 4 concrete tanks(each with capacity of 20 m^2), a cold storage system, a machinery complex(compressor, pump, etc.) and laboratory facilities. The Station since its started operation has conducted experiments on the rearing of P. monodon and Macrobranchium spp. in these tanks, but so far no results have been achieved. At present March 1971 the station staff is engaged in works in the same direction collaborating with two Japanese technicians dispatched under the Japan Overseas Cooperation Volunteer program, who are assigned to the studies of fishing gear and methods to collect gravid female shrimp. It is expected that the work will be completed in the near future.

Since the details of the experiments conducted at the Marine Research Laboratory at Naawan will be published by the laboratory staff in near future, the highlights of the work are introduced below.

The Laboratory was established on the sandy beach at Naawan several years ago with the financial support of the National Science Development Board. The station consists of two makeshift shacks (Photo. 10), one housing tank room and study room, and other engines. The rearing tanks is wooden with a capacity of 6 m^3 and sectioned into 3 compartments of equal dimension; other facilities include a number of aquaria and glass containers, all of which are placed in the tank room with the main rearing tank. The study room is equipped with a small tank and furnitures ; the workers stay day and night in the room. The engines provided are generator and a pump. The sea water is pumped up through a plastic pipe which opens directly in the sea.

The gravid females brought alive to the fishing harbor are transferred to a polyethylene bag (30 x 50 cm) inflated by clean sea water (90 % in volume of bag) and oxygen gas (10 %). The two bags, each carrying a shrimp, are put in a carton-box. The tip of the rostrum is torn off before the shrimp is placed in the bag. The shrimp thus placed in the oxygenated bag can stand 6 to 8 hours of transportation from fishing harbor to laboratory.

So far the experiments were attempted some 70 times, and of these, 10 experiments succeeded in breeding the larvae from hatching to postlarva stage. The results of the 70 experiments varied, ending in the failure of laying eggs, no hatching of eggs, suspending or retarding of development, low survival rate, etc. The causes responsible for the failures enumerated above are believed multiple, and the experiments were repeated from one to the next. For about 7 experiments, however, causality was made somewhat clear. In all of these cases, the cell division of eggs became retarded or ceased, and usually these eggs showed a growth of water mould on their outer surface; also these eggs, if not dying eventually, hatched out but only a few nauplii resulted. In all cases of the failures it was made clear that the sea was rough and wavy and the water in the rearing tank showed high turbidity though its salinity had not changed from the ordinary value of 28 to 33 o/oo.

The 10 cases of successful experiments, in which hatched out eggs were cultured to the stage of postlarvae, occurred in the months of March, May, August, September, November and February in 1970 and 1971. The research staff was convinced that the shrimp fry are available by tank operation in any time of the year if it is done properly. The results of the four successful cases are shown in Table 4, presenting some aspects of the survival rates of the larvae in the tanks.

Table 4. Record of the four experiments on the hatching and rearing in tanks of Penaeus monodon conducted at Mindanao State University Marine Research Laboratory, Naawan, in 1970. (Unpublished data)

Date	Tank No.	No. of females placed in tank	No. of spawners		Numbers estimated x 10^3					
			Full spawn	Partial spawn	Eggs	Nauplius (1)	Zoea (2)	Mysis (1)	Postlarvae (3)	(4)
March 17	II	2	2	0	976	845	170	5.3	2.6	1.318
May 20	III	2	0	2	487	378	137	23.2	20.9	9.720
Aug.14	I	2	1	1	513	496	163	41.2	36.7	12.394
Sept.22	III	1	1	0	164	131	122	53.2	41.9	23.754

The experiments and experiences gaived at the Marine Research Laboratory, Naawan, will be highly appraised not only for its achievement but also for large encouragements given to the research on shrimp biology and the development of shrimp culture in the country. Observation of the actual work on the site and the exchange of the views with the biologists resulted int the comments enumerated below : (1) the hatching and rearing of the larvae of Penaeus monodon are made possible in small tank as used here; (2) the same procedure of the work can be adopted for P. monodon and P. japonicus; (3) turbid sea water is unfavorable for the development of eggs and larvae (especially in earlier stages) of P. monodon as it is for P. japonicus; (4) by proper operation of the work the fry of P. monodon can be made available throughout year; and (5) the experiences gained in the operation of small tanks promiss success in the operation of larger tanks of over 60-ton capacity.

As to the feasibility of the culture of Penaeus japonicus in Philippines, the survey team was informed that the species may possibly be stocked into the pond, but they are not hardy compared to P. monodon in the water. They are inferior also to the treatment after the harvest from pond. It is apparent that P. japonicus prefer more sandy bottom than the other species, whereas, since the nature of the bottom of brackishwater ponds is usually muddy in the country, the condition is favorable for P. monodon. This information was supplied by several fish culturists contacted at Leganes and Lala, Mindanao, during the present survey trip. It was also learned that the unfavorable characters of P. japonicus were pointed out by a Japanese shrimp biologist, who had made a survey on this particular subject in the country several years ago.

IV BRACKISHWATER FISH CULTURE RESEARCH STATION UNDER THE BILATERAL PROJECT BETWEEN GOVERNMENT OF PHILIPPINES AND UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

Upon arriving in Manila in March, the present survey team received the program of the project fully described, accompanied by a number of blue prints of ponds and buildings. The pertinent parts of the program are extracted and presented as follows.

Objectives of the project : The ultimate purpose of this project is to augment current efforts of the government to step up food production to meet the diet requirements of the growing population. Among its goals, therefore, is the development of highly productive methods in culturing fishes, shrimps, oysters, and other seafood organisms.. Pertinent activities of this project include the training of biologists and extension specialists, both locally and abroad, in modern aquaculture techniques; and a program of demonstration and extension services throughout the country to disseminate valuable information to fish farmers and fishermen.

Significance of the project : Among a number of significant results expected from the project, it is pointed out that the inclusion of the training of technicians, extension workers, and fish farmers will improve the much-needed manpower for fishcultural activities of the government agencies and the industry, and also that this project station will in the future play a leading role in the participation of the Philippine Government in the regional fisheries endeavors of the Southeast Asian countries such as the SEAFDEC, to World Food Program in Southeast Asia, and other similar international undertakings. As to the nature of the bilateral project, it is noted that this proposed bilateral project

between the Philippines and the United States is to be implemented through the University of the Philippines and the USAID - Auburn University Contract as a cooperative fishery project of the governments.

Procedure and methodology : The project will :

1. Conduct researches necessary to develop more productive fish culture methods on milkfish, mullets, and other coastal species, oysters, shrimps and other shellfishes.
   (a) Formulate cheap and efficient fish feeds out of locally available materials.
   (b) Develop techniques of preventing fish kills due to asphyxia, parasites, diseases, etc.
   (c) Develop improved methods of pond construction and management for fish and shellfish cultivation.
   (d) Developimproved techniques in pond fertilization.
2. Develop laboratory-hatchery techniques of artificial breeding of fish, oysters, and shrimps, and other cultivable coastal organisms.
3. Conduct experiments to improve quality of fish and increase their shelf-life for more effective distribution and marketing.
4. Conduct training courses for fisheries students, extension workers, fish farmers.
5. Conduct periodic short courses to update fishery biologists in the Philippines concerning recent developments in aquaculture and management.

Schedule of activities: The construction of the ponds and buildings at the site of Leganes Municipality will be completed within two-year period. The research activities will start on a small scale in the first year, and training is scheduled to start from the second year, added to an expanded research program. In the third year the station will be in full operation.

The present survey team, however, was not informed in clear terms of the actual time schedule to start the project. A view was heard, on the other hand, that a special committee will be appointed by the government for the promotion of the project.

Budget : The costs of the project for the first 3-year period amount in total to 3,564,890 Pesos, shared by several government agencies and USAID as below :

National Science Development Board	1,752,890	Peso
University of Philippines	154,860	"
National Economic Council	105,800	"
National Food and Agriculture Council	12,000	"
Leganes Municipality	150,000	"
United States Agency for International Development	1,812,000	"
Total	3,564,890	Peso

Cooperating Agencies : Philippine Fisheries Commission (pond construction, training, extension and demonstration) ; Province of Iloilo (reconstruction of roads and bridge leadingt to the site); UN/FAO (3 scientists negotiated).

Personnel requirements : one Project-leader for a tenure of 3 years; one Assistant Project-Leader for 3 years; one Pond Superintendent for 3 years; two Senior Research Biologists for 3 years; one Research Biologist for 2 years; one Research Biologist for 1 year; one Research Assistant for 2.5 years; two Research Assistants for 2 years; one Clerk-Typist for 3 years; three Security men for 3 years; one Driver-Mechanic for 3 years; one Driver for 2 years; six Laborers for 2 to 3 years; one USAID Scientist for 2.5 years. Total 59 man-year.

The numbers of trainees and/or students to be enrolled at the station are not mentioned in the planning.

Layout and construction of ponds : The planning and designs on these subjects are presented by means of several sheets of blueprints prepared by the University of Philippines, some of which are copied in reduced scales and presented (Figs. 13 and 14).

According to the planning, the main supply of the waters to the ponds depends on the Jalaud River and Gui-gui Creek. The supply of the waters into ponds is made by the main supply canal running from west to east in the site and northward to the Jalaud River. The two rows of ponds are laid out on each side of this main canal. The drainage canals surround the rows of the ponds. The main supply canal and drainage canal are 8.5 and 2.7 m wide, respectively. One main gate of the water taken in and out is located at the canal opening to the Jalaud River and the other at the opening of the canal to Gui-gui Creek. Each gate is one meter wide and 3 m high from the base platform.

Fig. 13 shows the layout of the ponds at the station. These include 12 ponds (one hectare each), 24 ponds (0.1 hectare each) and 24 ponds (0.05 hectare each) ; one storage reservoir one hectare wide, which is attached to 12 raceways one meter wide and about 30 m long. The ponds are constructed to hold water 45 m deep (the bottom of the ponds is inclined toward the outlet gate). It was commented by the Philippine workers that the receways were included in the station pond project at the request of the Auburn University fishculturist, but the objectives for their use were not made clear. It was explained also that the "moving water" to the raceways is supplied from the storage reservoir with the aid of pumping if necessary.

The construction and dimension of the dikes and gates are designed in detail. However, the management of the water taken into and drained from the ponds is not clearly explained nor illustrated on the blue-prints referring to the changing tidal levels in the Jalaud River and Gui-gui Creek, the two main sources of water supply to the ponds.

Building : The main buildings planned at the station include the Fish Processing Laboratory (27 x 8.15 m wide) and the Service Warehouse with the same floor area, these two buildings being separated by on 8m-wide open court (Fig.16). The dormitory building for the trainees and students, measureing 39 x 8.95 m plus 9 x 5.2 m in floor space, is another main building (Fig. 17) planned for the station It will accomodate a total if 32 persons. These two major buildings will be constructed on an unoccupied lot of triangular shape (Fig. 15), covering a floor area totalling about 630 m^2.

In the Fish Processing Laboratory Building there are 3 laboratory rooms each measuring 50 m^2. It is understood that the trainees will work together with the researchers (10 persons are being required) in these rooms. It was explained that a classroom for lectures or a conference room for discussion and seminars are not provided. Air-conditioning is not considered.

As to the lot for these buildings, a view was heard that the selection of the present lot as shown in Fig. 15 is not final, and there is a possibility to that the lot might be shifted to other convenient space available on the site.

Supply of freshwater and electric current : Since the supply of freshwater can be expected only after the discovery of underground water within the site area, deep-well drilling will start earliest in the program of the project. It is hoped the drilling will be successful.

The source of electricity is dependent on private power generation, not on power supply from the municipality. It is reported that the current circulated to both station and dormitory is generated by two generators of 50 and 60 km capacity, which are used alternately.

Equipment : A complete list of the equipment which was prepared by the workers of the national project was presented, covering machines, tools, instruments and others required for the operation of the station. The list enumerates about 100 items, each with specification, number of articles and price. The equipment will all be furnished within 3 years, but with priorities for certain items.

The items are listed classified into the 6 categories shown below;

Pond construction	5	items
Aquaculture	11	"
Water chemistry studies	26	"
Fish nutrition	27	"
Fish disease	27	"
Others	9	"

(It is anticipated that these items will be carefully checked against those required by the SEAFDEC project in order to economize on the budget of the two projects and to avoid useless duplication.)

V PROPOSED BRACKISHEATER FISH CULTURE STATION, DEPARTMENT OF AQUACULTURE, SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

The present paragraph was drafted by the members of the survey team based on the results of the survey and other studies at the site of Leganes and observations made at other places in the Philippines. It is clearly understood that the contents in the most of the subjects dealt with do not convey a sense of committment, Rather, they should be considered as material for further discussions among the parties concerned with both national and regional projects planned at Leganes.

Objective of the project : As has been recommended by the SEAFDEC Council, the Station at Leganes will undertake research and training primarily on the cultivation of shrimp. The other assignments of the Station are dissemination of the knowledge and information in the field of aquaculture and related activities as requested by the Council.

Significance of the project : The project merits high praise especially in the light of regional cooperation in Southeast Asia to develop aquaculture in the region. It is hoped that the Aquaculture Station at Leganes, Panay Island, will exemplify a showcase of effective international cooperation.

Procedure and methodology : Referring to the programming of research and training to be conducted at the Station, due consideration was made in the studies on the present status of scholarly works of aquacueture and activities of specialists, socio-economical significance of the works, and government policy directed to the works.

The studies as such concluded that "effectiveness" or " practicality" should be the golden-rule in carrying through the activities of the Station, whether in research or training. For the planning and execution of research works, mature deliberation will be needed to bring the results of the research up to direct and immediate uses in the actual operation of fish culture. The training in principle and practice should be programmed to produce practical fish culturists. It may be added in this connection that the trainees for extension works are to be practical men, in order to be able to adwise and help fishermen.

Under the principle of the "effectiveness", subjects for the research to be taken up in the initial stage of the station are considerered to be as follows :

(1) Survey on shrimp production in ponds under different natural and management conditions.

(2) Ecological studies (with emphasis on food habit and environmental effects) of the adult and young shrimp in natural and pond waters.

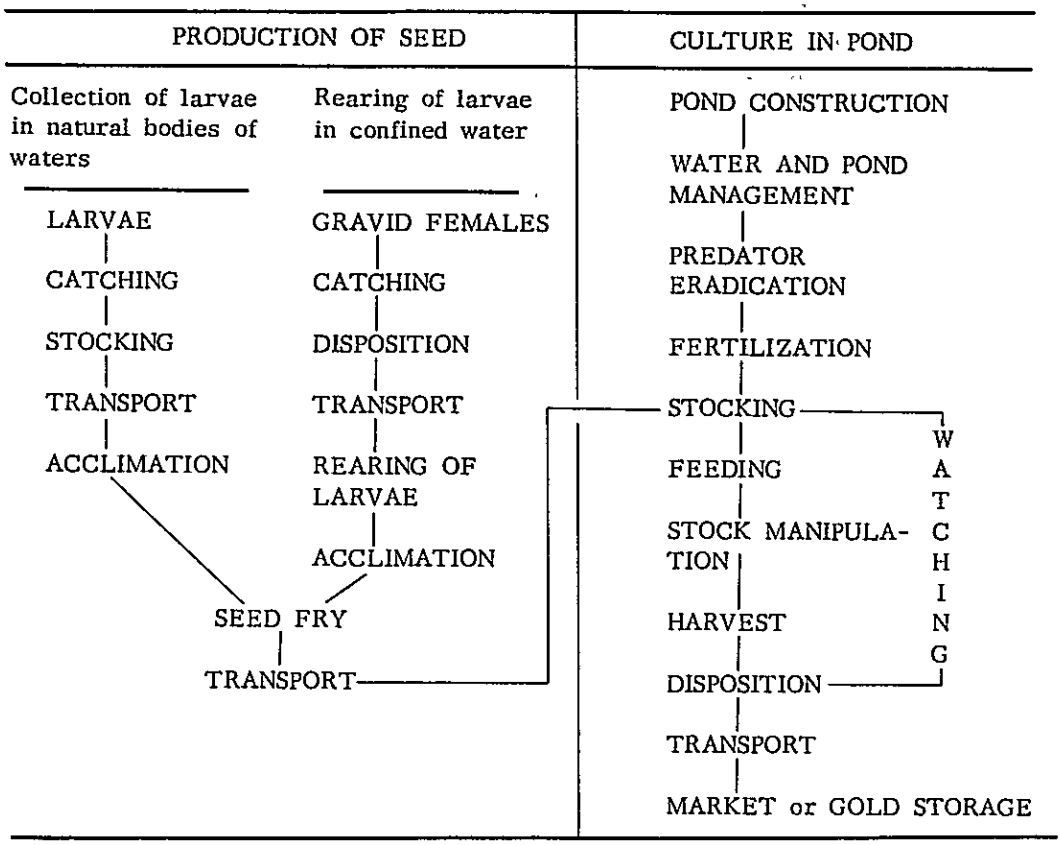
(3) Studies on plant and animal communities in ponds.

(4) Bio-assay studies on the effects of chemicals and other substances to organisms in ponds.

(5) Experiments on feeding of shrimp by natural and prepared foods.

(6) Studies on the effects of fertilizers to biological productivity in ponds.

"Effectiveness" or "practicality" must be applied in same way to research activities. There are believed to be different methods to achieve the objective technically and in discipline. One of the technical methods proposed is to cover all problems concerned with fish culture operation, so that the trainees will realize that their task will be accomplished and finished at the moment of the crop harvest. In the case of shrimp culture the diagram introduced below will explain the process of the culture starting from the collection of the fry and ending with the harvest of the seed fry previously stocked into ponds. The trainees must understand by practical works and discipline the fact that if any of the subjects involved in the process of shrimp culture is missed or neglected, no satisfactory crops can be expected.



Under the discipline the subjects of the training or curriculum of the course through lectures, demonstration and laboratory and field works are selected in following major categories : (1) supply and management of pond water, and design of ponds; (2) collection and associated biolology of adult and young shrimp; (3) hatching of larval shrimp and its rearing in confined water; (4) culture operation of shrimp in ponds from stocking of the fry to harvest of the product.

The course of training will be given for a one-year period beginning in January each year. The first one month will be devoted to subject (1), the following 7 months to subjects (2) and (3), and remaining 4 months to subject (4). The above schedule, however, will be modified, adjusting to the biology of shrimp and other various conditions.

Schedule of activities : At the time of the survey the present team did not have the basis to obtain definite terms on the subject. But, the programming of the project should proceed under close contact with the Philippine side.

Budget : Commitment of any sort concerning the financial matters of the project must wait until the future when the overall program of the project may be further materialized or/and finalized.

Personel requirement : To carry on the research and training as programmed, researchers and other workers will be required. The list of the personnel below is given by professions or jobs and the number required.

Director	1
Biologist	1
Chemist	1
Engineer	1

Fishculturist	1
Hydrologist #	1
Planktologist (= Algologist) #	1
Counterpart researchers	6
Clerk	2
Librarian	1
Pond care-taker and janitor	4
Driver	1
Boat-man	1
Dormitory attendant	4

It is anticipated that personnel qualified as researchers (senior) will be provided by SEAFDEC and the rest by the host country. It is desirable also that specialists marked # will be assigned to duties on a part-time basis but all the rest on a full-time basis, and that the senior researchers will be recruited from the member and non-member countries within and outside the region.

Trainees : It is self-explanatory that the trainees enrolled to the station should be qualified equally in their educational and career experience. Thus, rigid regulatory measures will be needed in the invitation and enrollment.

From a technical point of view and our experience, it would be appropriate to limit the number of the trainees for one year course to about 20 persons when the station enters into full activity. But, during the initial stage of the activity, 2 to 3 years, it would be much realistic the number be limited to 10 or less.

Layout and construction of ponds : Under the understanding between the survey team and counterpart researchers the SEAFDEC station was allotted about 10 ha in area in the southwesten side of the site (Fig.13). The layout and the construction plan of the ponds on the allotted area are explained in the end of the present chapter.

The fish ponds are experimental in nature. They are not designed nor operated for the production of shrimp. It is required therefore that the ponds be able to fulfill the following conditions : (1) change and flow of the water in and out the ponds be effective and substantial; (2) the salinity of pond water (due to evaporation, rainfall and other factors) be controlled as desired; (3) the temperature of the pond water be controlled as desired by the change of water; (4) the management of the pond including handling of the gates be made with ease and conveniently; (5) the pond bottom be leveled to allow complete draining.

To respond to these conditions, the system of main canals to collect sea water from Gui-gui Creek and river water from the Jalaud River has been designed (Fig. 21). The present system, it is reminded, is proposed to supply the waters needed for the operation of all the ponds constructed in the site with a total surface area of about 40 ha.

The main canal indicated as MC 1 in the figure, running wholly through the site from west to east, opens to Gui-gui Creek without being blocked by gate. Water from the Jalaud River is taken by another canal MC 3, which is followed by MC 2 extending to either side of the batteries of ponds. Under the system every pond in the site can lead in both river and creek waters directly or indirectly from the respective canals; the ponds of smaller sizes receive the waters through the ditches collectively constructed (see Fig. 25).

Since the function of the canal is to transfer as effectively as possible the potential energy of the sea water (due to fluctuation of tidal level) to the pond, it was

necessary to determine the size of canal properly. To answer the problem it was held that the φ_p / φ_c (meaning level fluctuation of pond water and the same of canal water, respectively) must approach 95 %. Also, the level fluctuation of sea water at the entrance of the canal should be sought. Next, mathematical treatments derived a graph (Fig. 18) showing the relationship of surface area of the pond (S ha) to the cross-section area of the canal under the condition φ_c / φ_o = 0.90 or 0.95 (where, φ_c is level fluctuation of canal water, and φ_o the same of sea water). Under the above theoretical process, it is concluded that the cross-section of the canal (MC 1) should be designed to measure 25 - 30 m^2 for the operation of all the ponds in the station with a total surface area of about 40 ha.

The designing of the other canals (MC 2 and MC 3) is also to be made with a similar theoretical process as the above. In this case, however, the amount of water required from the Jalaud River by the station must be clarified with due precaution on the fluctuation of the water level and the salinity of the river especially during the wet season. Under the limited information on the subjects obtained during the present survey, it is considered appropriate and sufficient that the canals MC 2 and 3 are designed so as to allow the flow of water amounting 1/3 and 2/3 that of MC 1, respectively.

The diagramatic drawings (Fig. 20) illustrate the cross-section views of the two canals designed based on the above theoretical process, together with the dimension of the dikes. The canals are to have an inclination of about 1/3000 ; CM 1 inclines toward the creek, and MC 2 and 3 toward the river.

The water gates attached to the canals, as shown in Fig. 21, include the main gate Gl at the end of the main canal MC 3, gate G 2 which blocks MC 1 from MC 2, and two other gates, G 3 and G 4. Gate G 1 will not only regulate the flow entering from the Jalaud River into the main canal MC 3 but also prevent the inflow of the flooded water into the canal. The two gates, G 3 and G 4, are required for the control of river water supplied to ponds and gate G 2 for the separation of the creek (sea) water and river (fresh) water. Under the main principle that the amount of the two kinds of waters to be taken into the ponds be adjusted by the two gates constructed to each unit of pond; the gates on the main canals can be designed to allow the smooth passage of waters running in the canals.

It may be commented here that the crosssection of the main gate on the main supply canal (on the Gui-gui Creek side), though not prosed by the survey team, must have a dimension of at least 10 m^2 (see Fig. 19) in order to make use of high potential energy of the tidal fluctuation for the supply of sea water to 40 ha of ponds. If it measures 3 m^2, it is possible for the gate to utilize only 20 to 30 % of the tidal energy, a gate of this size is believed to work more in blocking other than passing the water.

The ponds proposed for the shrimp culture experiments include 6 units of 9,000 m^2, 10 units of 1,000 m^2 and 18 units of 500 m^2, which are laid out in Fig. 25. The level of the bottom of these ponds is designed to be + 40 cm above the datum level of the station or M.L.L.W. line at Leganes coast. The shape of each pond, regardless of the size, is so designed, with the position of the water gate also considered, as to make the inflow water spread evenly in the pond and to affect the outflow in the same way. The diagramatic drawings in Fig. 23 will explain the change of stream lines which are drawn by the two flows in the pond.

To enable the ponds to receive sea water and river water separately and in the amount desired, each pond is provided with two gates which are located diagonally. The construction of the gate is designed and presented diagramatically in Fig. 24.

The same design will be applied to each of the 3 kinds of ponds noted above. The dimension of the gate, or precisely the diameter of the culvert pipe, will be determined referring to the graph shown in Fig. 22. It is noted here that the value of AC (A, cross-section in area of the pipe ; C, coefficient of flow) is subject to varied conditions such as the length and diameter of the pipe, but the value of C = 0.7 will be adopted in most of the cases. Also, an allowance of 5 cm added to the radius of the pipe is recommended considering probable growth of organisms on the inner wall of the pipe.

As a supplement to the foregoing paragraphs a commentary note may be given here concerning the mathematical process to determine the size of the water gate in relation to the size of pond. The construction of the graphs as shown in Figs. 18. 19 and 22 represents the process.

The amount of flow passing through the gate can be obtained by the knowledge on the passage of level fluctuations from outside to inside the gate. This passage is expressed by the formula $h_0 = \frac{\varphi_0}{2} \sin \frac{2\pi t}{T}$ for the level outside, and $h = \frac{\varphi}{2} \sin \frac{2\pi}{T}(t - \Delta T)$ for the inside. (h and h_0 are water levels outside and inside the gate ; φ_0 and φ, tidal difference outside and inside ; T, tidal period ; ΔT, time difference between outside and inside the gate ; t, time.) These two formulas, further extended, construct the graphs whown in Fig. 27. In these graphs the value of φ_0 / gT^2 is a available from the tidal range in the region of Leganes which is known figure, and S / AC is also given, and then φ and ΔT are obtained.

Buildings and facilities : The buildings and other facilities required and proposed for the operation of the station are enumerated below. It is held, as will be seen in the details of design, that construction, dimension etc. of these are not given. Rather, the approximate size (floor space) of the constructions and a few comments are given.

It is noted that the general policies conserning the buildings at the present moment include : (1) air-conditioning will be provided for most of the buildings ; (2) the dormitory will be established in the station site but air-conditioning is not considered ; (3) the generation of the electric current as required will be shared by the two parties ; (4) the detailed construction of the buildings is designed following a local customs and traditions ; (5) the planning of the buildings and other facilities will be finalized through intimate negotiations expected henceforth among the parties concerned.

Administration House (Including Director's Office, Administration Room, Lobby, Corridor and Toilet)		130 m^2
Laboratory Building		455 m^2
	Chemistry Lab.	50 m^2
	Biology Lab.	50 "
	Chemistry Experiment room	50 "
	Biology Experiment Room	50 "

Lecture Room (large)	60	m^2
Lecture Room (small)	30	"
Dark-room	15	"
Library	50	"
Space for Corridor, Toilet, Shower-room, etc.	100	"
Service House	321	m^2
Garage (2 jeeps, 1 dump-truck and 1 swampdozer)	80	"
Warehouse	60	"
Food-shop	30	"
Refrigeration system (3-ton holding capacity, preparation-room, engine, etc.)	38	"
Cold-air Chamber	13	"
Machine Shop	50	"
Engine Room (2 generators, 4 pumps, 2 blowers, etc.)	50	"
Aquarium Corner (partly out-door with shed)	150	m^2
Rearing-Tank Shed	120	"

(20 5-ton tanks, 2 filtration system etc.)
(Attached to or located close to Service House)

Survey Boat
(10 m long; 7 ton; plastic made)
Jetty installed on Gui-gui Creek (15 x 2 m)
Dormitory
(Planned to accomodate 20 persons with special attention given to design and equipment for satisfactory living conditions of traninees)

Supply of freshwater and electricity : Freshwater, the prime reguisite for living and the operation of the station, must be sought underground at the site. The rain and river waters can hardly be reliable for the purposes both in quality and quantity.

The present survey did not cover the work of checking the underground water on the site, but it was confirmed that there was no freshwater well in the region which would be capable to serve the uses of the station. There is one deep well at a milkfish farm located across the Jalaud River, and another one in a community about 3 km west of the station site. These two sources of freshwater, however, are far beyond consideration. The people in several communities close to the site are believed to depend largely on rain water, and it was observed frequently that they were carrying water in tin cans.

Under such conditions in the region it is sincerely hoped to start the drilling of a deep well at the station site as soon as possible. It is feared that a failure, if this should happen, to successfully hit an underground water source within the site might demand a drastic change in the whole project.

The supply of electricity will depend entirely on the station's own power generation. The supply of current from Leganes Municipality is not included in the consideration.

Equipment : The machines, tools, equipments and instruments required to conduct research and training primarily on shrimp culture are listed below. The list giving the type and number of each item is by no means complete, because a definite design for the structure of laboratory rooms, experimental tanks, etc., has not yet been prepared. The list will be considerably modified with the progress of the planning.

Items for the library and training :

Office typewriter (electric)	3
Portable typewriter	2
Fuji Xerox copying machine	1
Adding machine (electric and manual)	5
Telephone (room to room communication)	10
Overhead projector	8
Videocorder	1
Tape recorder	2
Loud speaker	2

Items for biological studies and experiments :

Universal projector	1
Binocular microscope	14
Balance	10
Tortion balance	2
Time switch	5
Stop watch	3
Microtome	2
Drying chamber	2
Thermostat	1
Glass aquarium	20
Blood corpuscle counting slide	20
Plankton counting slide	50
Centrifugal machine	3
Water propeller	2
Electric transformer	5

Items for biology field works :

Dissolved oxygen tester	2
Water sampler	2
Bottom sampler	2
Turbidity meter	2
Salinometer	2
Winkler oxygen analyzer	1
Redox meter	1
Hydrophotometer	1
Ph meter (electric)	2
Plankton net	5
Hydrometer (for S.G.)	20
Walky-talky	3
Thermometer	20
Core sampler	1
Microscope (portable)	2
Dinghy (plastic)	2
Binocular	2
Transistor radio	2
Recording thermometer	10
Ice box	5
Plankton sedimentation tube	200
Outboard engine	3
Ph meter (colorimetric)	10
Secchi disc	2

Items for land survey and hydrography :

Transit	2
Level	3
Pole and stave	12
Tape scale	2
Pantograph	1
Planimeter	1
Echo-sounder	1
Slide-rule	20
Tracing table	1
Water guage	12
Current meter	10
Thermister	5
Point guage	40

Items for weather observation :

Wind-vane (anemometer)	1
Photometer	1
Rain guage	1
Sunshine recorder	1
Hygrometer	1
Temperature recorder	1
Barometer	1
Instrument screen	1

Items for cultural operation and outdoors works :

Canvas makeshift tank	3
LP gas bomb	3
Creener	1
Grinder	1
Panlite tank	80
Root blower	2
Condenser	1
Vertical pump	4
Diesel engine (portable)	2
Bomb (air or oxygen)	4
Water filtration system	2
Platform scale	1
Motorcycle	2
Bicycle	2
Jeep	2
Dump truck	1
Swampdozer	1
Generator (portable)	2

Items for chemical studies and experiments :

Balance	10
Ph meter (electric)	2
Gas-chromatographer	1
Rotary evaporator	1
Electric heater	1
Condenser	1
Vacuum pump	1
Waterbath	1
Spectrophotometer	1
Centrifugal pump	1
Membrane filter	1
Freezer	1
Refreigerator	1
Water filtration system	2

Items for survey vessel :

Vessel (10 m ; 7 ton), FRP.	1
Hand winch	1
Water sampler	5
Bottom sampler	3
Thermister	2
Salinometer	1
Plankton-net	5
Larvae-net	3
D.O. meter	1
Skin diving set	1
Fishing gear	20

Items for photography :

35 mm camera	3
Underwater camera	1
Microscope camera	1
Slide-projector	1
Screen	1
Photography dark-room set	1
8 mm movie-camera	1
16 mm movie-camera	1
Movie-projector	2
Tripod	2
Flashlight (stolobo)	3
Exposure meter	2
Camera accessory set	1

It is anticipated that these items will be carefully checked against those required by the Philippine national project in order to economize on the budget of the two projects and to avoid useless duplication.

VI THE FUTURE PLANS

To carry on the planning of the two projects at Leganes, the time schedule of the work to be conducted must be borne in mind. Following the recommendation of the Council Meeting at Manila in January this year, the plan of the project of SEAFDEC, including physical set-up and the operation of the proposed station, is to be presented for approval to the coming Council Meeting at Bangkok scheduled in March 1972. Under this conditions, the planning must have been finalized by that time or, if not, materilized as far advanced as possible.

In order to achieve progress in the planning according to the time schedule, utmost efforts must be made first of all to bring the works shared by the parties concerned under the full understanding of the principle of international cooperation.

During the rainy season in 1971 (July to September) a second survey on the site will be required with the following main objectives : (a) to accumulate more data especially on the hydrological features of the waters on and around the site ; (b) to gain more information on the biology of adult and larval shrimps in the areas ; (c) to extend further the discussions among the parties concerned on the planning including pond designing, buildings and other facilities as well as the general plan of operation of the two projects.

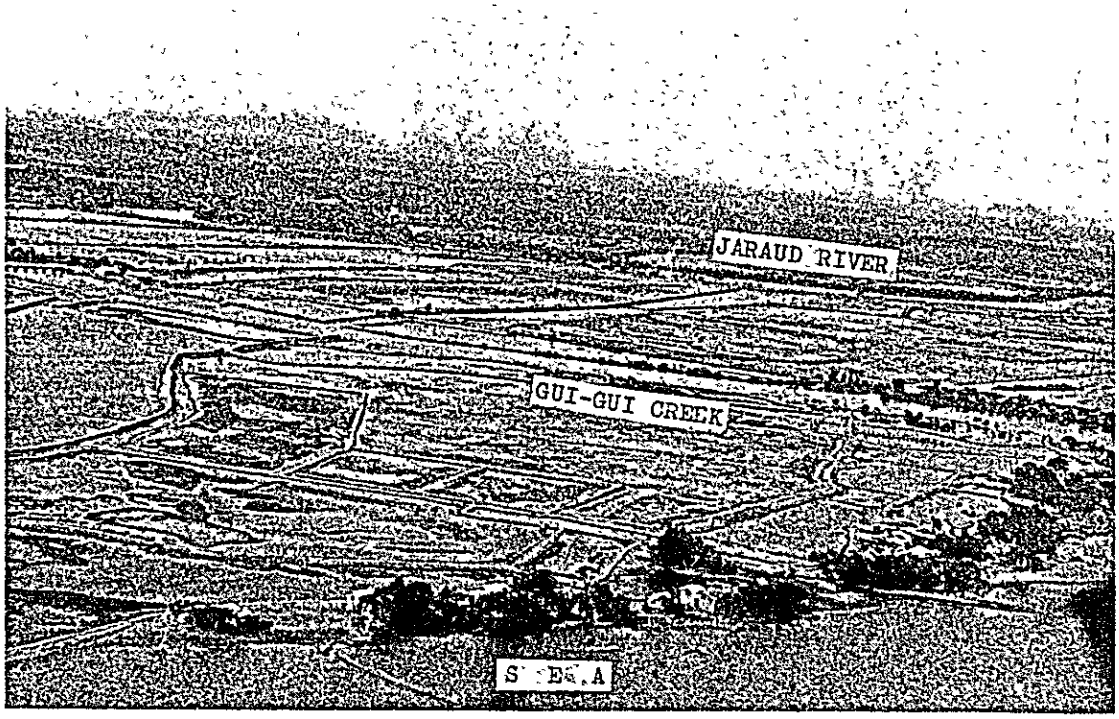


Photo. 1. Aerial view of a part of the station site interposed between the Jalaud River and the Gui-gui Creek and adjoining areas on the coast of Leganes, Iloilo Province, Panay Island. See Fig. 4 for reference on map. (January 19, 1971)

Photo 2. Panoramic view of the station site at Leganes seen from a house located about 150m south of the Bench Mark 1 (see Fig. 4), the view extending from about 345° to 95° of the house. Scene on the top shows the Jalaud River and a community on river side, and a part of the main canal running SSE in the site is shown on the bottom view. (March 21)

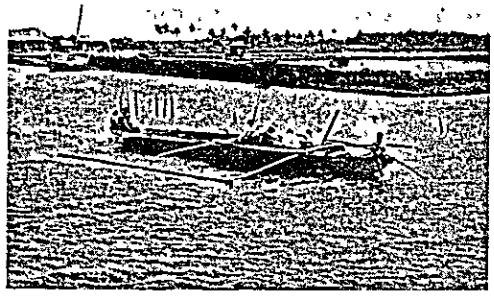


Photo. 3. The Gui-gui Creek seen from the opposite bank of the station site; the vessel in the middle of flow chartered for the survey. (March 26)

Photo. 4. The Jalaud River viewd from the side of the station site; a bar scale tied to the half submerged mangrove tree was used for the reading of water levels made on March 27. (March 25)

Photo. 5. Water gate on the end of main canal in the station site opened to the Jaland River. Picture taken by Dr. M. Nakamura on March 23.

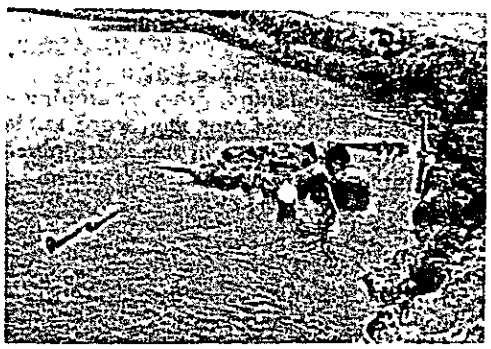


Photo. 6. A part of the dike on a fish pond near the site; a young boy is working in patching the dike by bottom mud brought over by bamboo raft. (March 26)

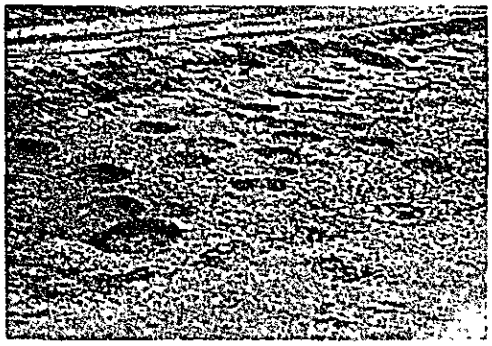


Photo. 7. Group of spawning-nests of tilapia found on dried up bottom of a pond in the station site. Picture taken by Dr. T. Kafuku on March 22.

Photo. 8. Association of sea-snail (Cerithidea *sp) on dired up bottom of a* pond in the site, a common ecological view everywhere in the region. (March 20)

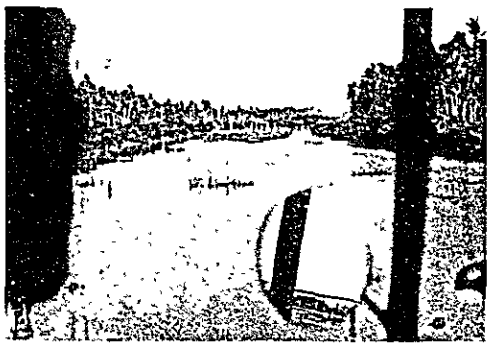


Photo. 9. View of the Batiano River about 4 km upstream from the mouth; fish weir in far back, and submerged "shrub" in front, which are remains of a device to trap larval shrimp during rainy season. (April 1)

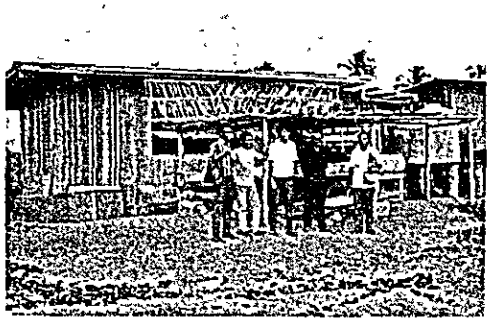


Photo. 10. Buildings of Marine Research Laboratory, Mindanao State University, Naawan, Mindanao Island, where hatching and rearing of Penaeus monodon were made in tanks for the first time in the Philippines; the biologists in front are the staff of the Laboratory. (April 11)

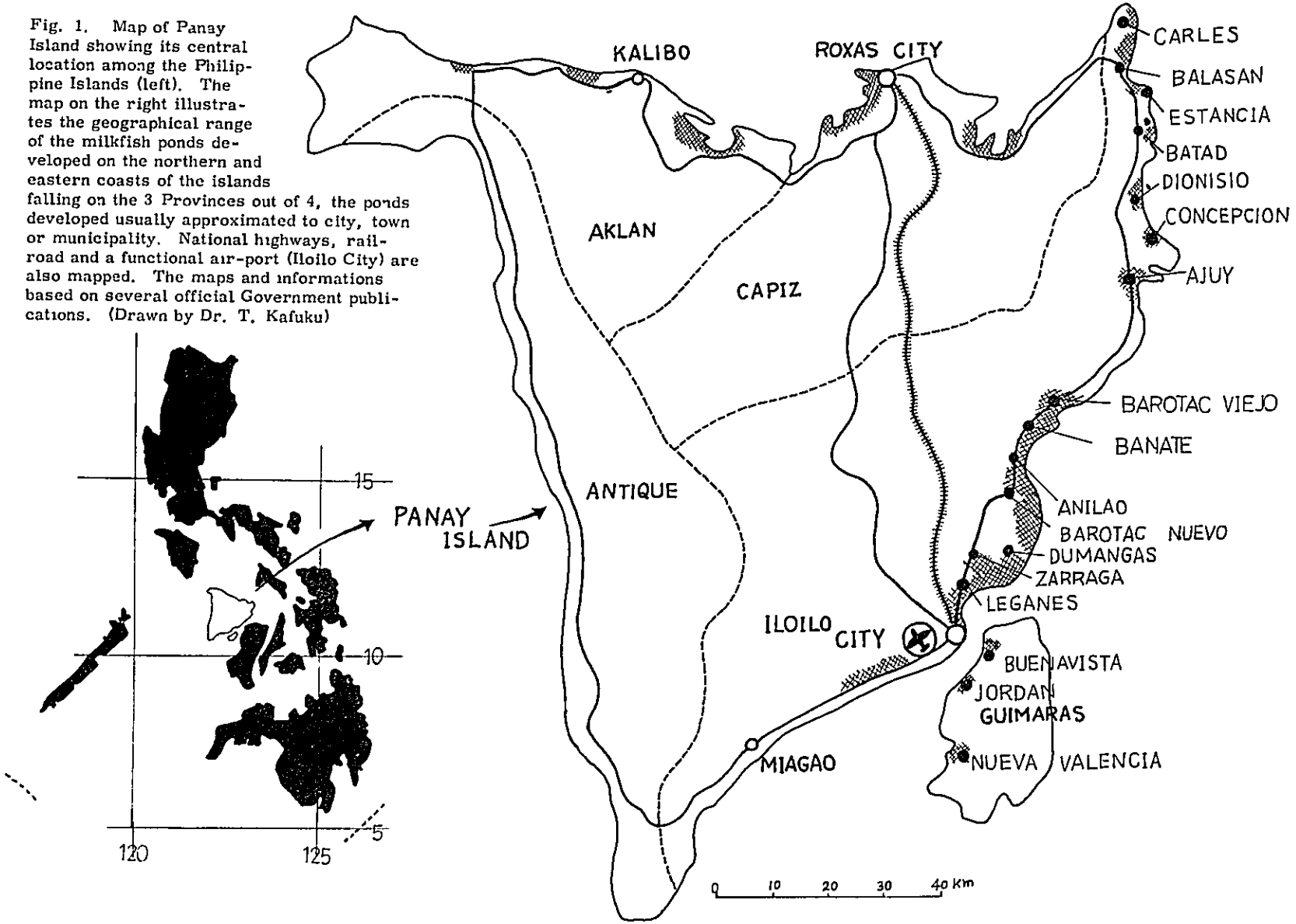
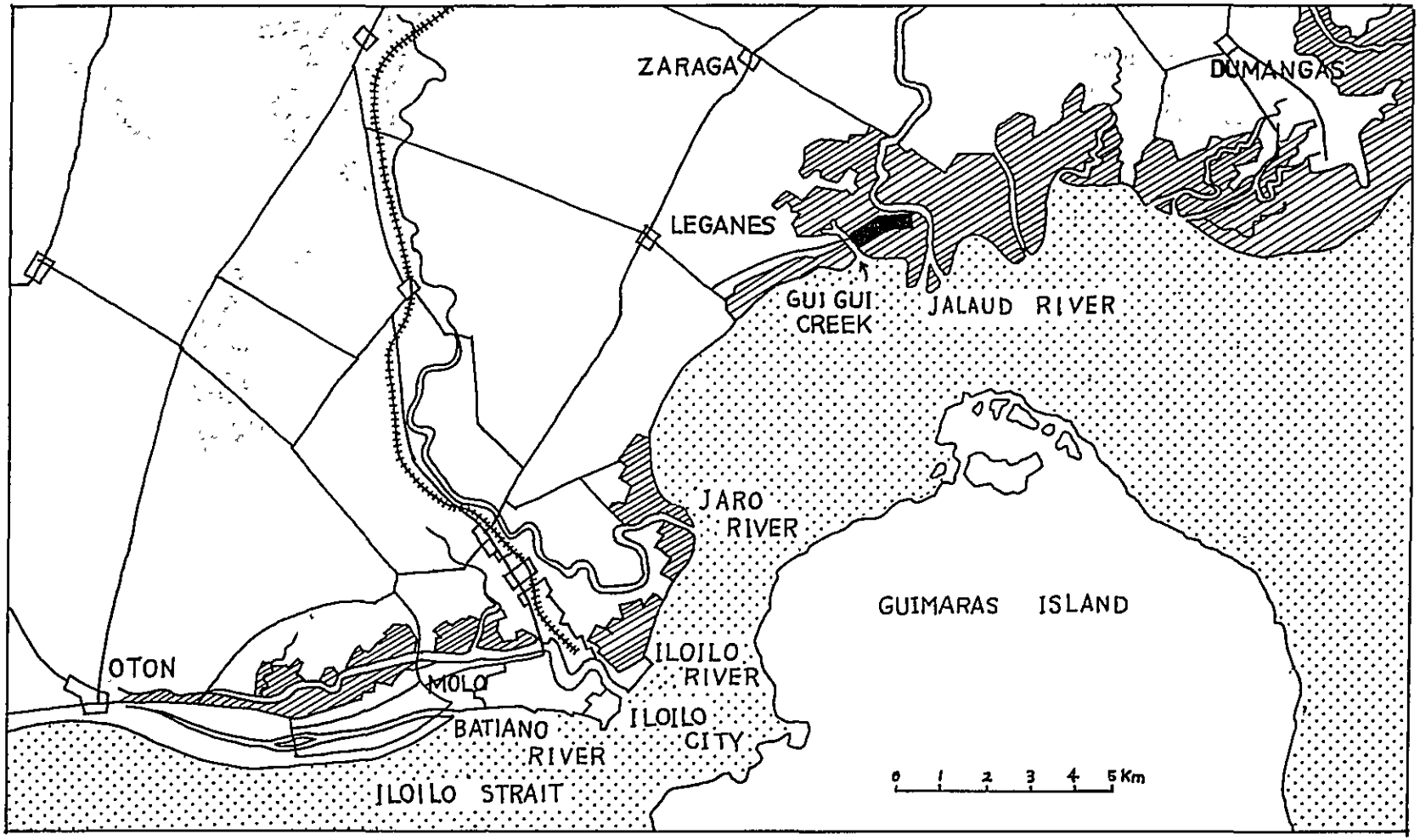


Fig. 1. Map of Panay Island showing its central location among the Philippine Islands (left). The map on the right illustrates the geographical range of the milkfish ponds developed on the northern and eastern coasts of the islands falling on the 3 Provinces out of 4, the ponds developed usually approximated to city, town or municipality. National highways, railroad and a functional air-port (Iloilo City) are also mapped. The maps and informations based on several official Government publications. (Drawn by Dr. T. Kafuku)

Fig. 2. Map to show the site in Leganes Municipality (Iloilo Province, Panay Island) of the Brackish-water Fish Culture Station under cooperation projects of the Government of Philippines and the South-east Asian Fisheries Development Center, and the neighbouring regions from Oton to Dumangas with the development of milkfish ponds and salt drying-tanks shown by the demarkation of oblique lines. The Guimaras Island, Iloilo Sub-Province is appended. Abridged from 1;50, 000 topographic map, Board of Technical Surveys and Maps, Sheets 3552 II and III. (Drawn by Dr. T. Kafuku)



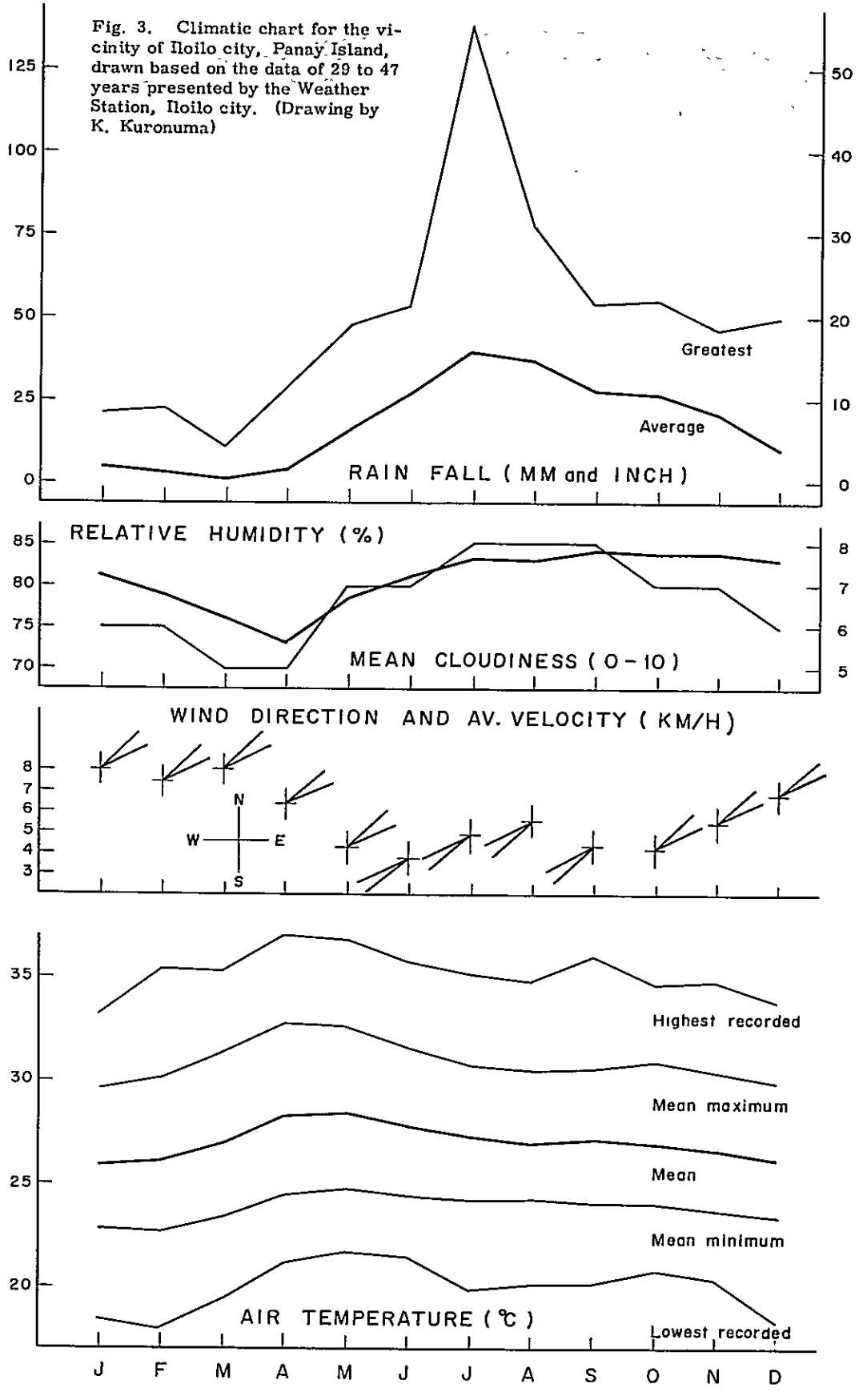


Fig. 3. Climatic chart for the vicinity of Iloilo city, Panay Island, drawn based on the data of 29 to 47 years presented by the Weather Station, Iloilo city. (Drawing by K. Kuronuma)

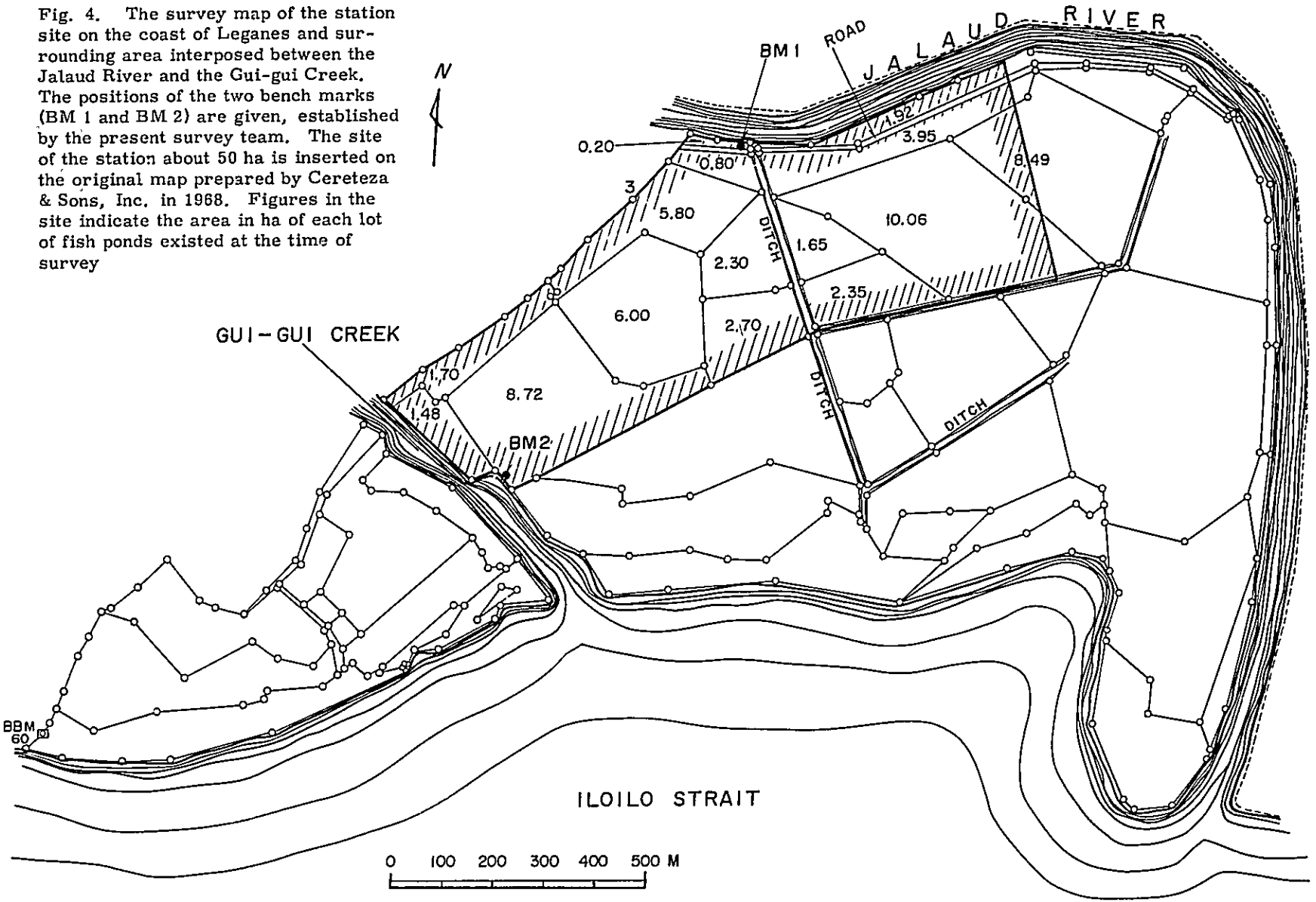


Fig. 4. The survey map of the station site on the coast of Leganes and surrounding area interposed between the Jalaud River and the Gui-gui Creek. The positions of the two bench marks (BM 1 and BM 2) are given, established by the present survey team. The site of the station about 50 ha is inserted on the original map prepared by Cereteza & Sons, Inc. in 1968. Figures in the site indicate the area in ha of each lot of fish ponds existed at the time of survey

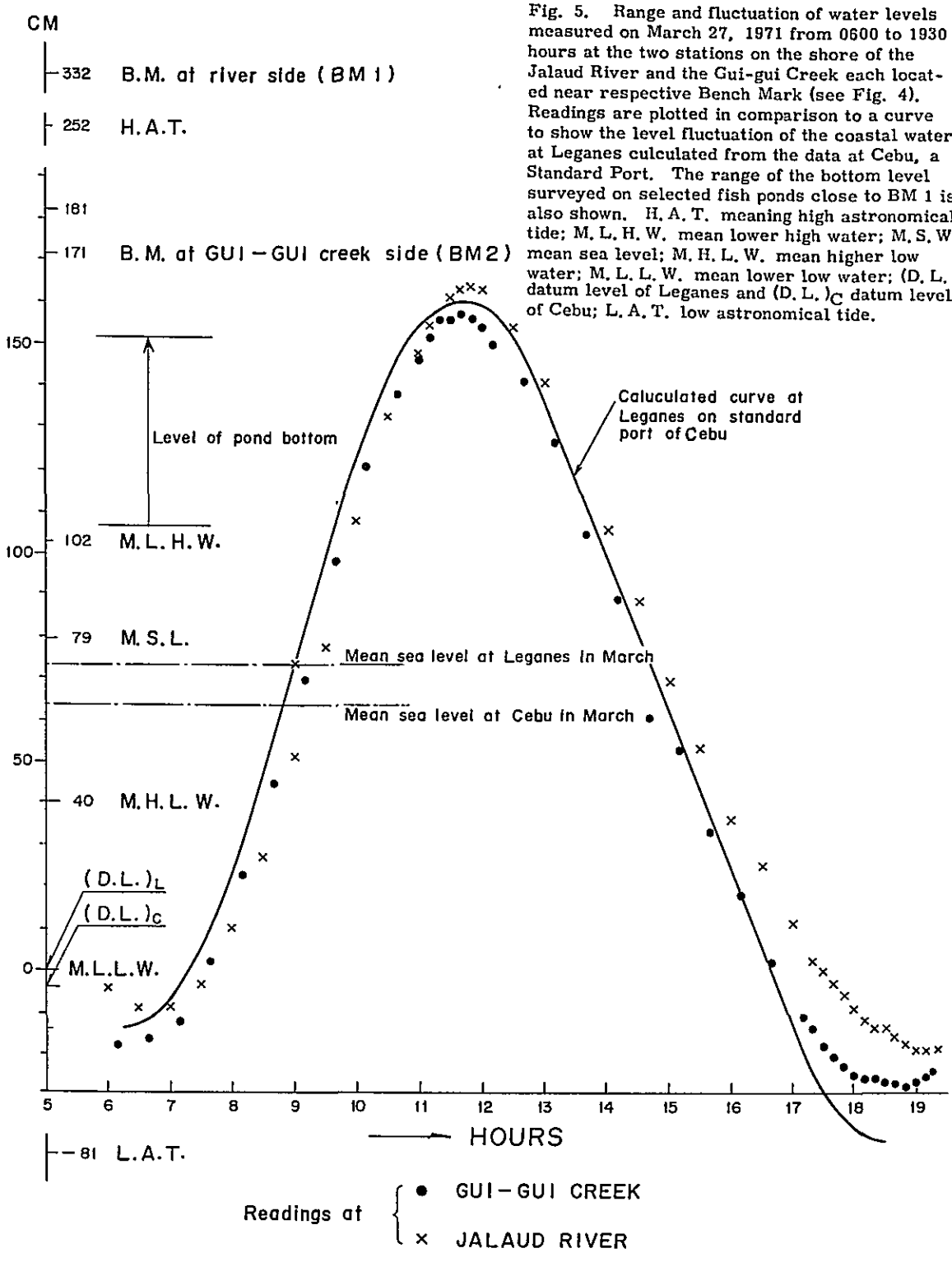


Fig. 5. Range and fluctuation of water levels measured on March 27, 1971 from 0600 to 1930 hours at the two stations on the shore of the Jalaud River and the Gui-gui Creek each located near respective Bench Mark (see Fig. 4). Readings are plotted in comparison to a curve to show the level fluctuation of the coastal water at Leganes culculated from the data at Cebu, a Standard Port. The range of the bottom level surveyed on selected fish ponds close to BM 1 is also shown. H. A. T. meaning high astronomical tide; M. L. H. W. mean lower high water; M. S. W. mean sea level; M. H. L. W. mean higher low water; M. L. L. W. mean lower low water; $(D. L.)_L$ datum level of Leganes and $(D. L.)_C$ datum level of Cebu; L. A. T. low astronomical tide.

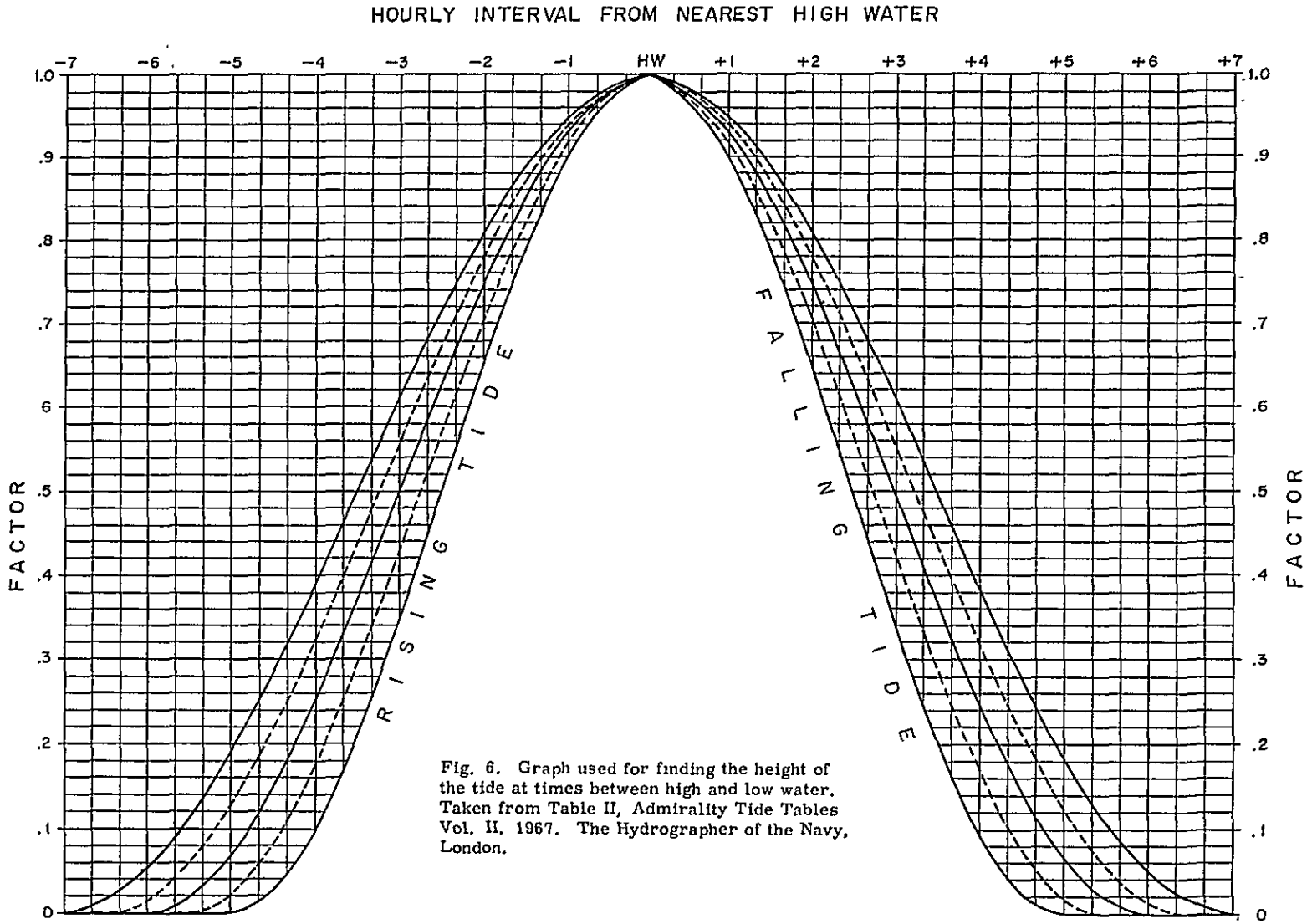


Fig. 6. Graph used for finding the height of the tide at times between high and low water. Taken from Table II, Admiralty Tide Tables Vol. II, 1967. The Hydrographer of the Navy, London.

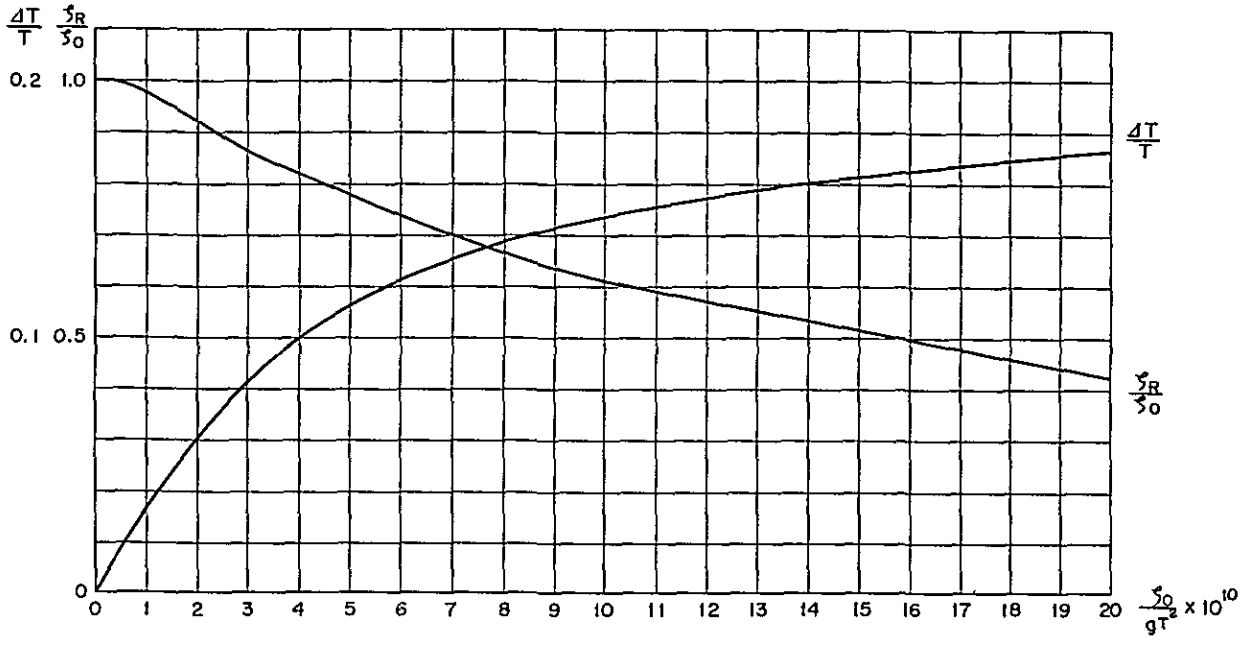


Fig. 7. Graph constructed to show the relation of the formulae (2) and (3). See text.

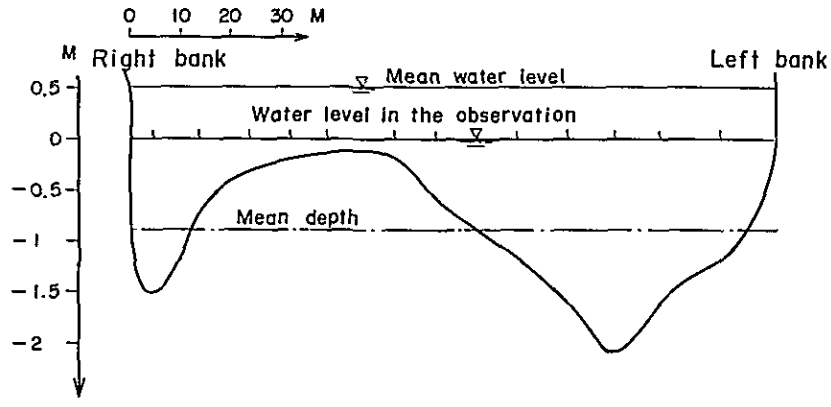


Fig. 8. Cross section of the Jalaud River in front of the BM 1 (see Fig. 4) located about 2.5 km upstream from the mouth, based on the soundings of 12 spots across the flow attempted on March 26, 1971 between 1520 and 1550 hours.

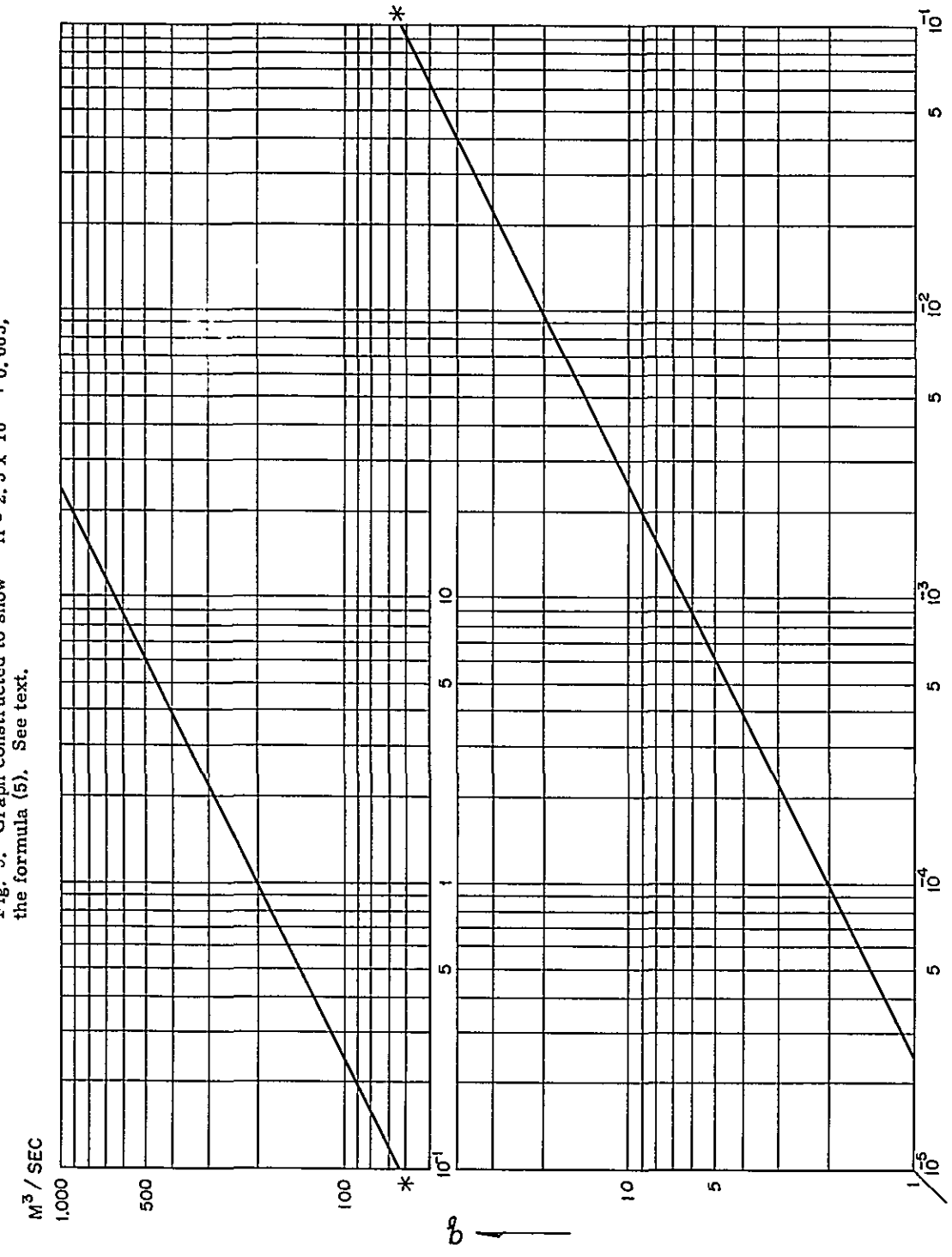


Fig. 9. Graph constructed to show $H = 2,5 \times 10^{-5} + 0,065$, the formula (5). See text.

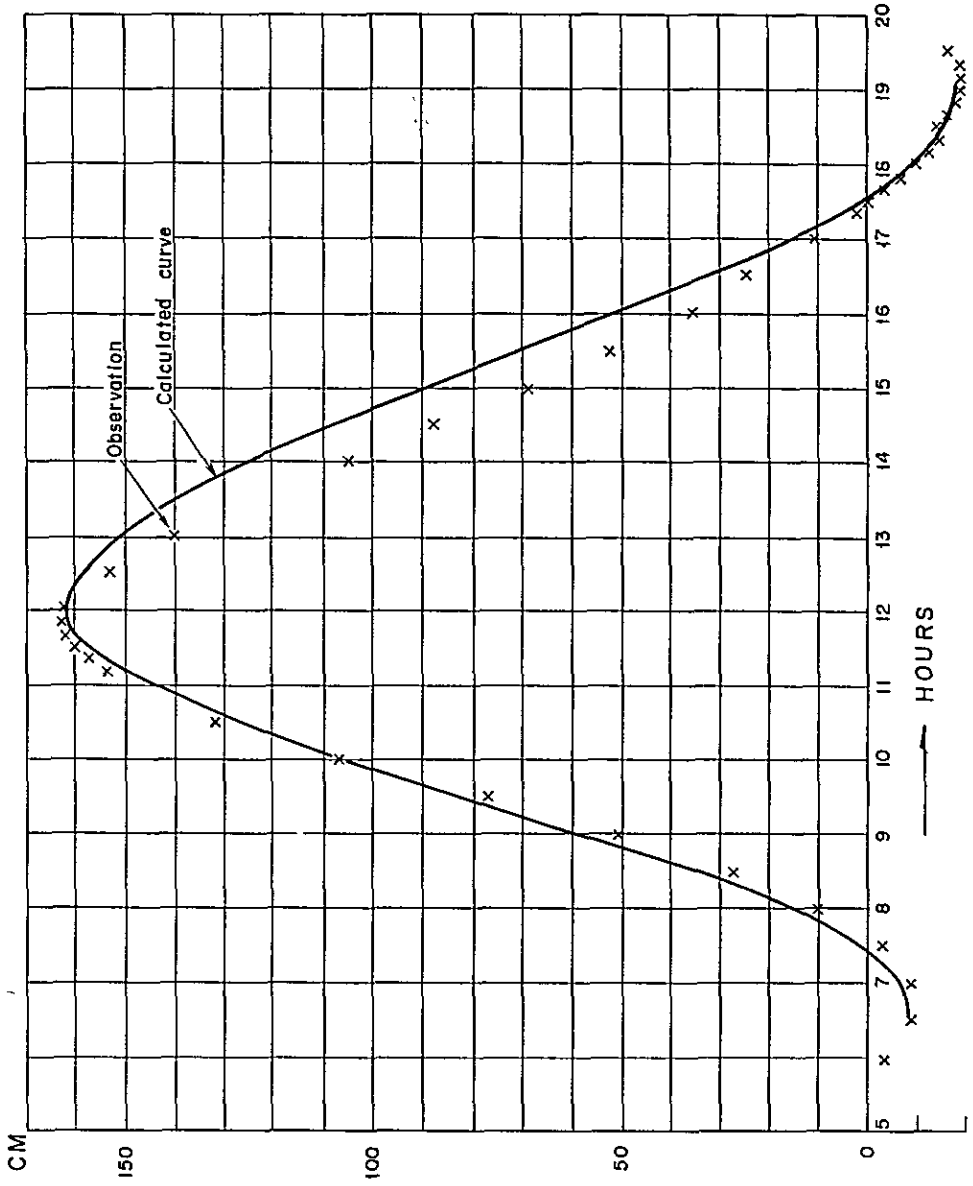


Fig. 10. Range and change of the water level of the Jalaud River observed on March 27, 1971, 0630-1930 hours (see Fig. 5). The readings are plotted in comparison to a linear curve showing the same fluctuation of the water level but calculated from the flow of water (see text).

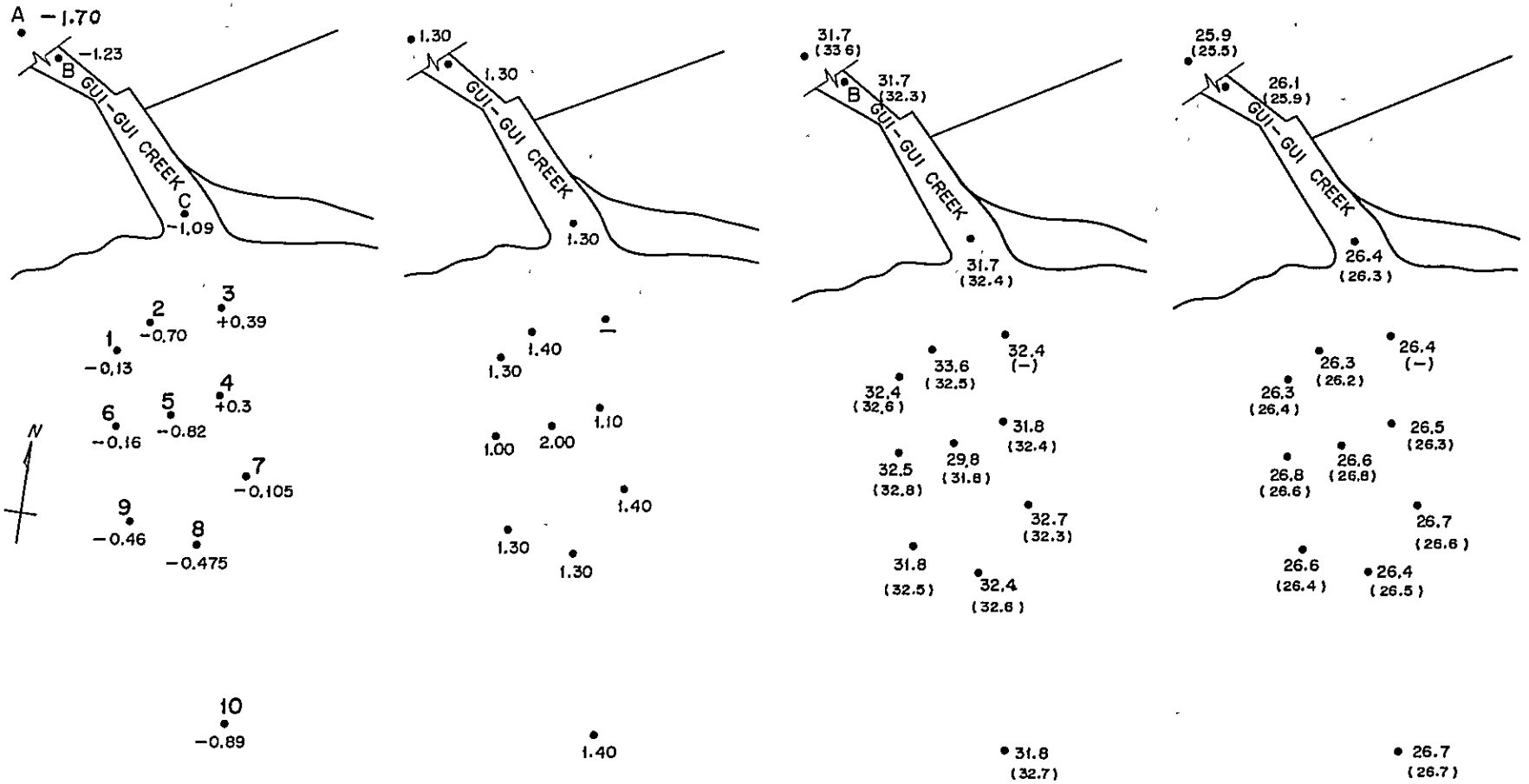


Fig. 11. Result of the hydrological survey conducted on March 26, 1971 between 0918 and 1303 on 3 stations (A, B and C) within the Gui-gui Creek and 10 stations in estuarial water. From left to right : depth of water in meter expressed referred to lower low sea level; transparency in meter of Secchi disc reading; salinity (o/oo) of surface and in parenthesis bottom water; temperature in °C of surface and in parenthesis bottom water. Plotted from the data in Table 2.

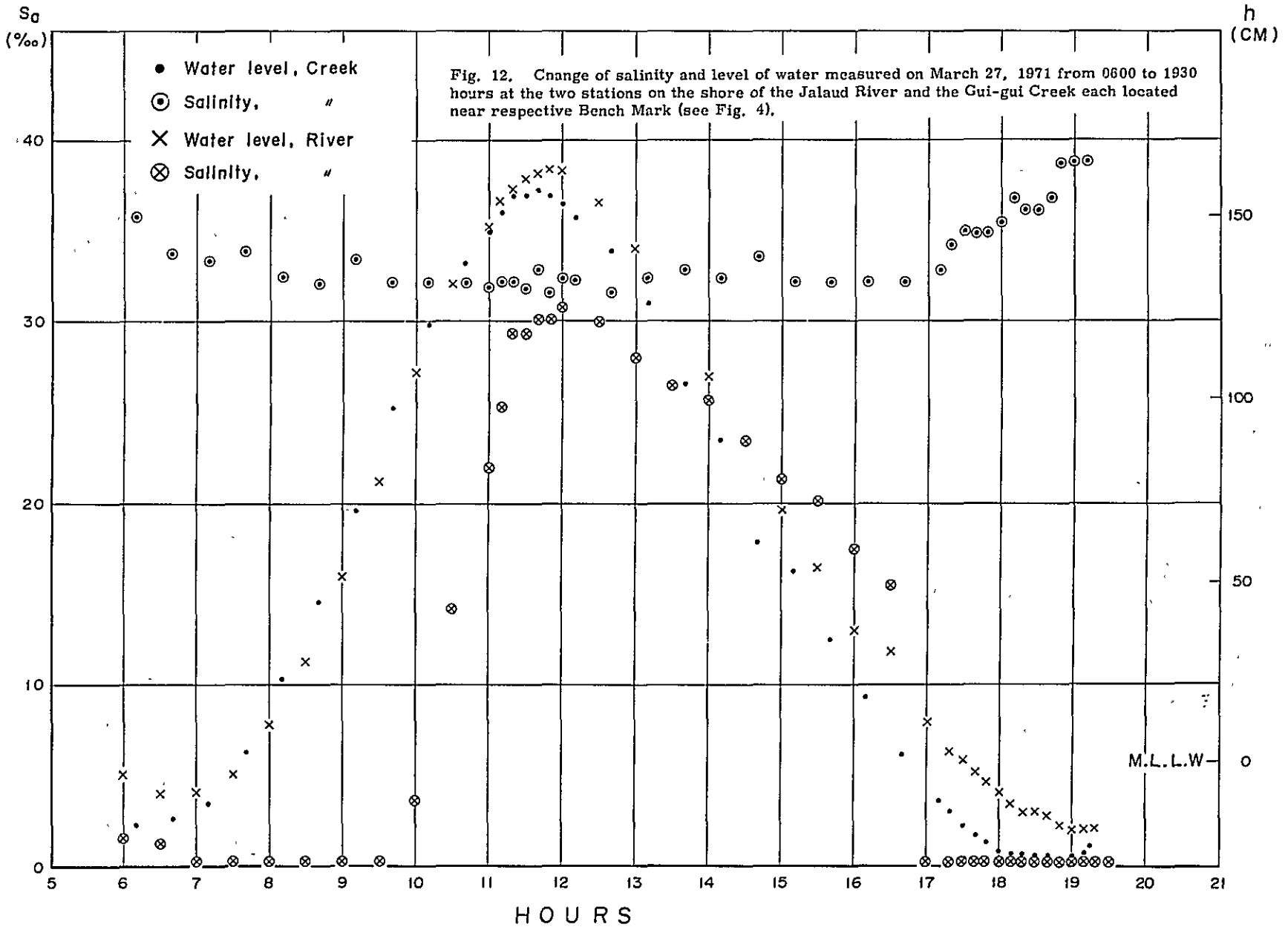


Fig. 12. Cnange of salinity and level of water measured on March 27, 1971 from 0600 to 1930 hours at the two stations on the shore of the Jalaud River and the Gui-gui Creek each located near respective Bench Mark (see Fig. 4).

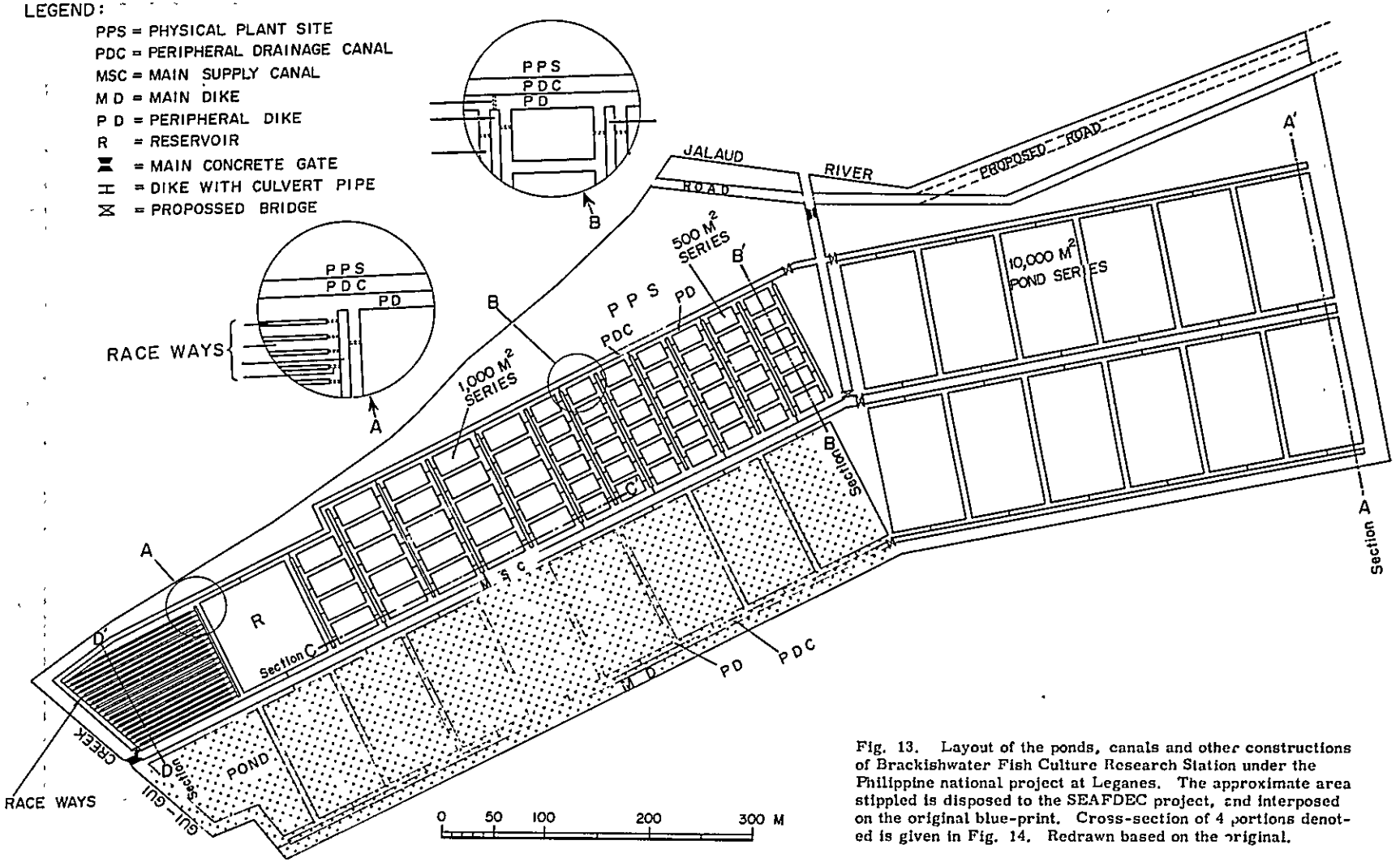


Fig. 13. Layout of the ponds, canals and other constructions of Brackishwater Fish Culture Research Station under the Philippine national project at Leganes. The approximate area stippled is disposed to the SEAFDEC project, and interposed on the original blue-print. Cross-section of 4 portions denoted is given in Fig. 14. Redrawn based on the original.

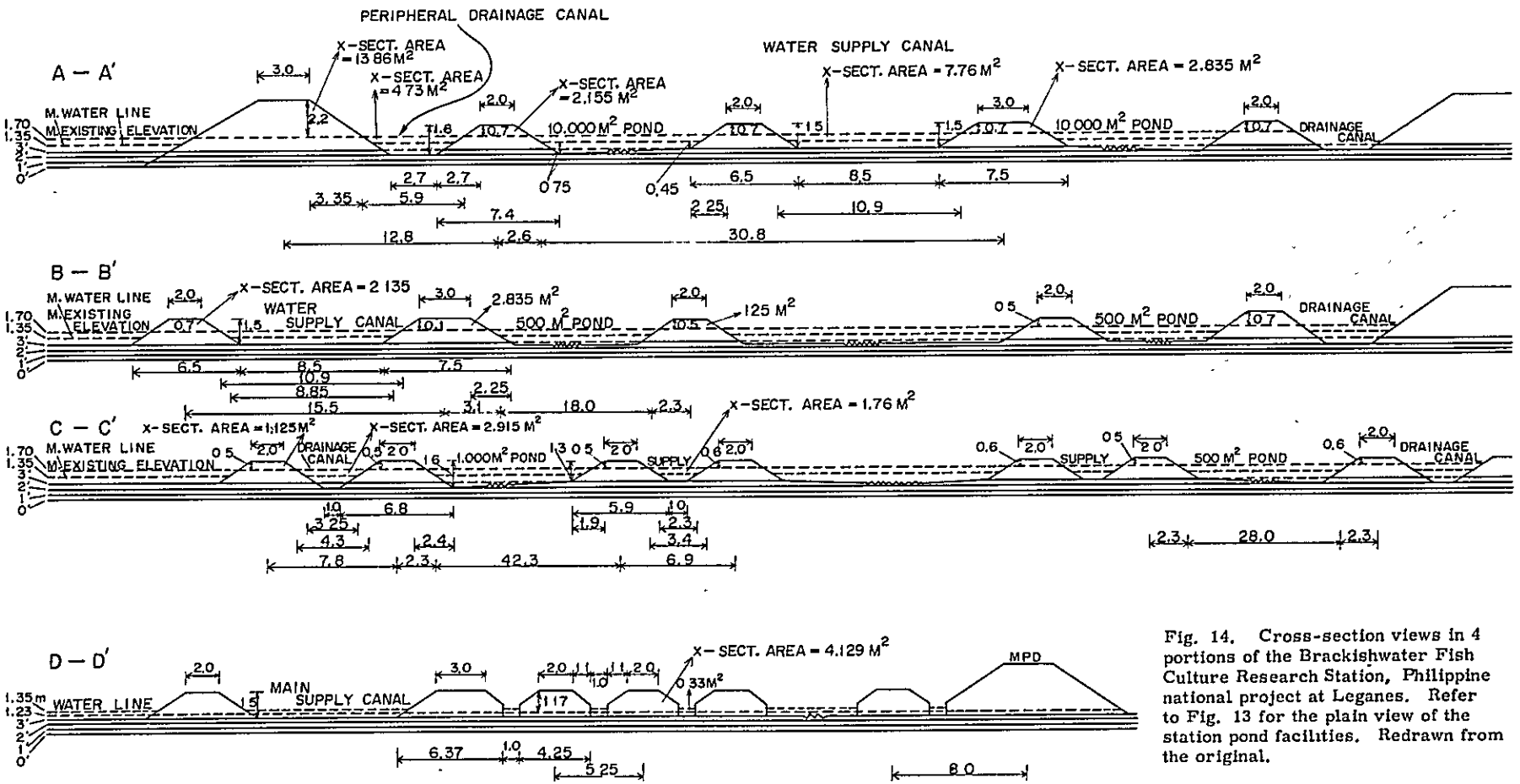
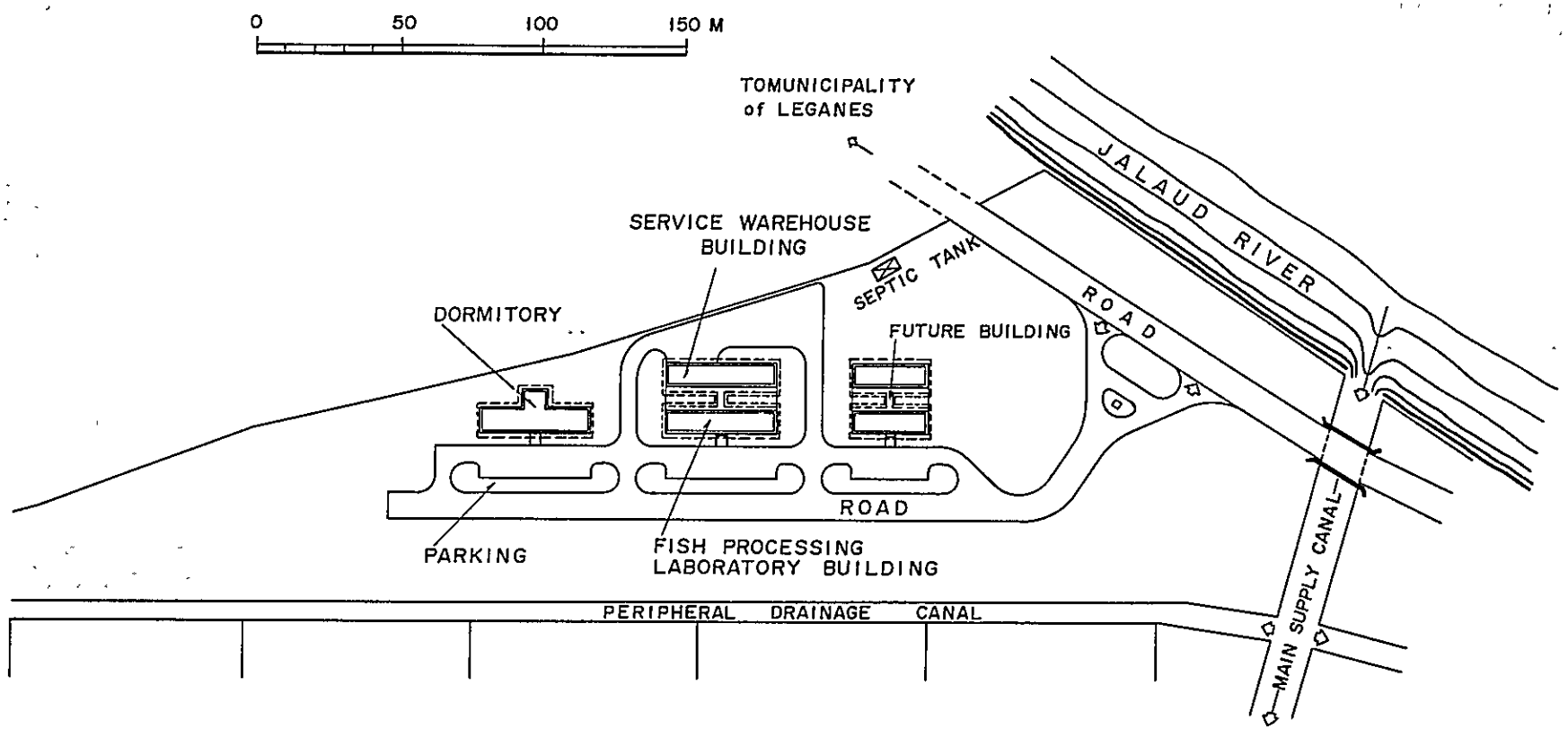
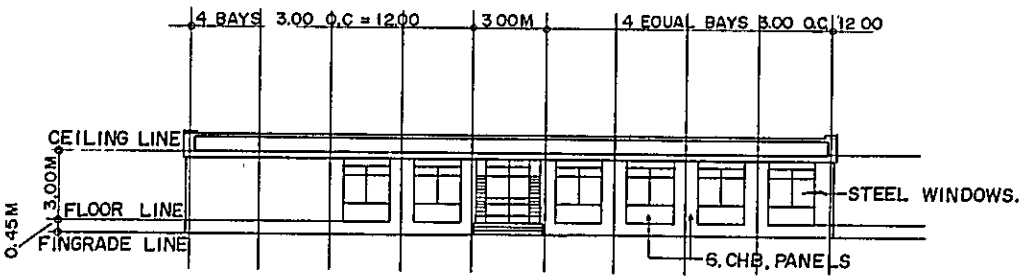


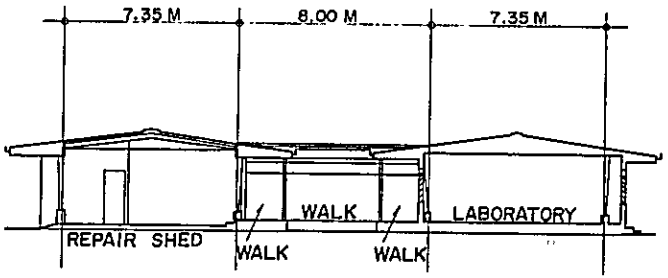
Fig. 14. Cross-section views in 4 portions of the Brackishwater Fish Culture Research Station, Philippine national project at Leganes. Refer to Fig. 13 for the plain view of the station pond facilities. Redrawn from the original.

Fig. 15. Location plan of the buildings and other constructions of Brackishwater Fish Culture Research Station, Philippine national project at Leganes. Redrawn from the original.

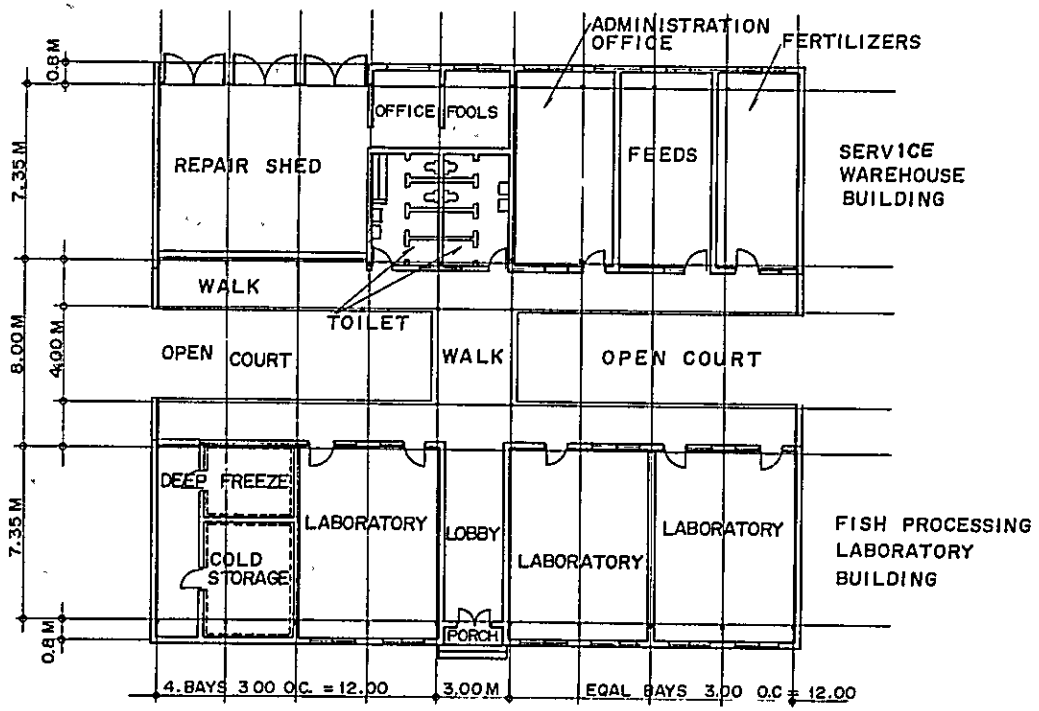




FRONT ELEVATION



CROSS SECTIN



FLOOR PLAN

Fig. 16. Plan of the main building of Brackishwater Fish Culture Research Station, Philippine national project at Leganes. Location of the building in the station site is given in Fig. 15. Redrawn from the original.

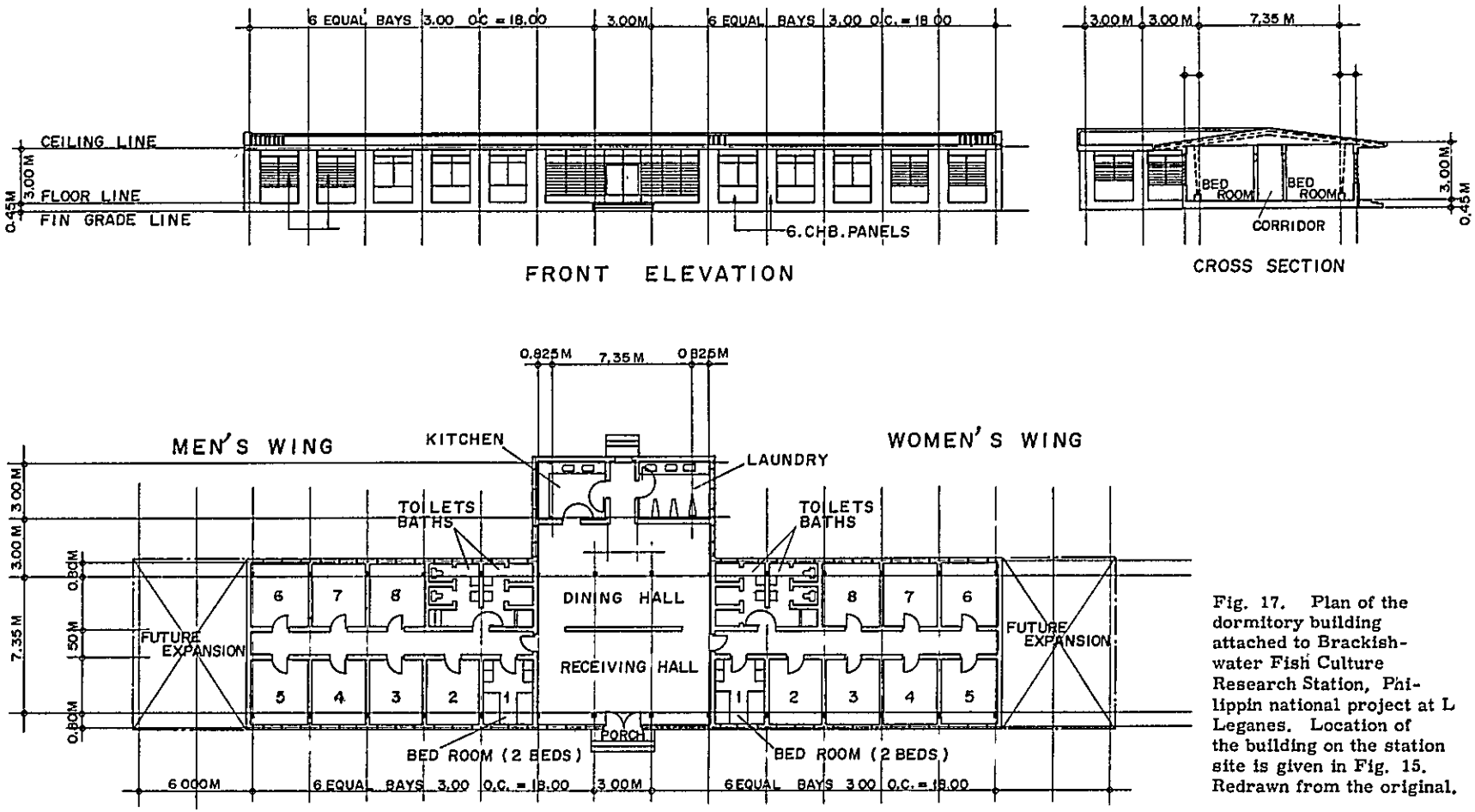


Fig. 17. Plan of the dormitory building attached to Brackishwater Fish Culture Research Station, Philippin national project at L Leganes. Location of the building on the station site is given in Fig. 15. Redrawn from the original.

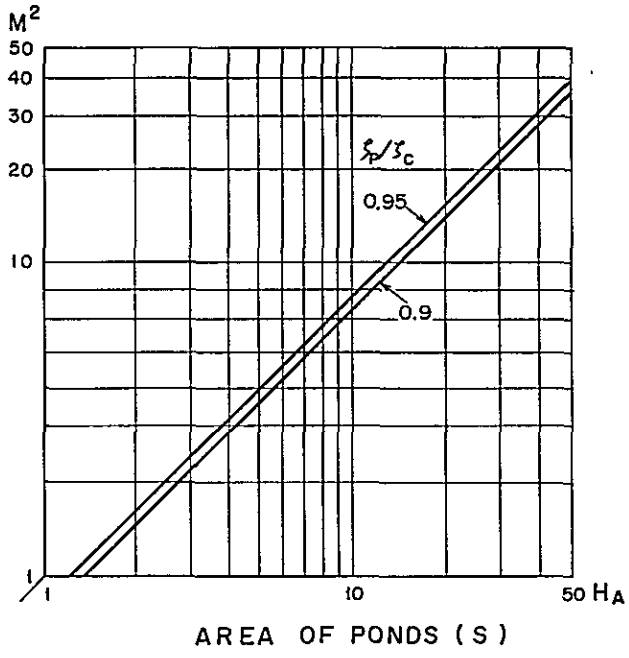


Fig. 18. Graph to show the relation of the area of pond and the cross-section area of the passage under the full (90 - 95%) use of the potential energy of tidal change.

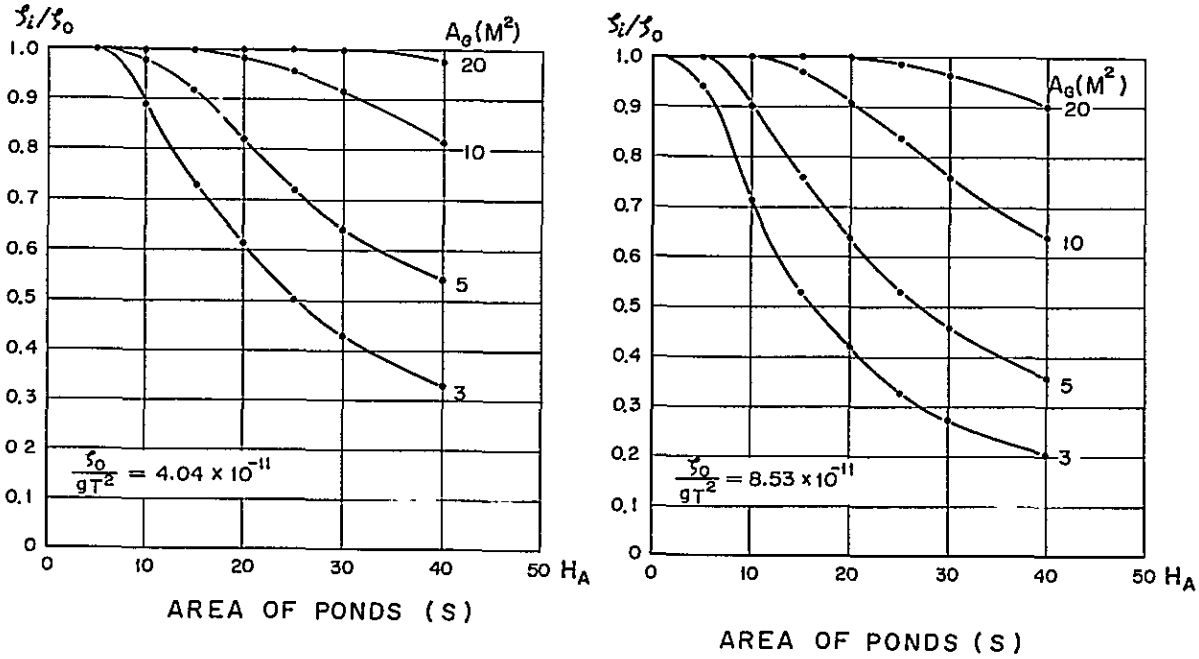


Fig. 19. Graph to show the relation of water gates of different sizes to the areas of ponds according to the different efficiency in use of the potential energy of tidal fluctuation. Left figure for the neap tide and the left for spring tide. Calculated for reference uses in the Leganes region.

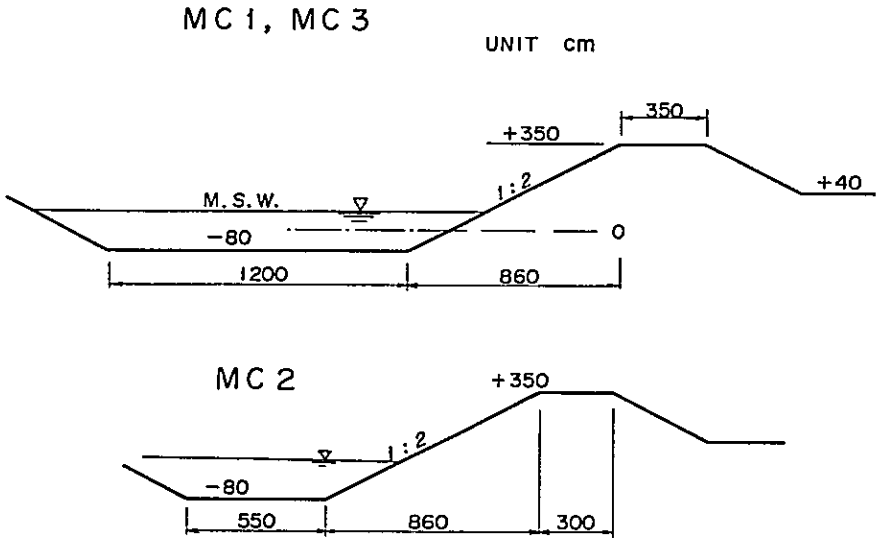


Fig. 20. Cross-section views of the main canals (MC 1, 2 and 3) and the dikes, the plan proposed by the survey team for the general layout of the pond system on the site.

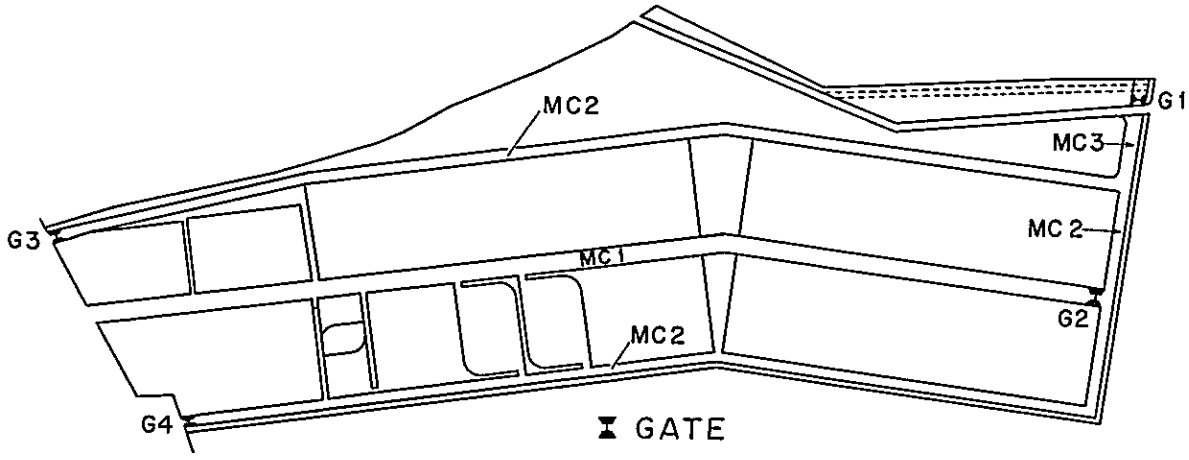


Fig. 21. General layout of the canal system (MC 1, 2 and 3) and the positions of the gates (G 1, 2 and 3) referring to the batteries of ponds used in both national and regional projects. Plan proposed by the survey team.

Fig. 22. Graph to show the relation of the size of gate and the area of pond to result effective passage of the flow, calculated for the reference uses in the region.

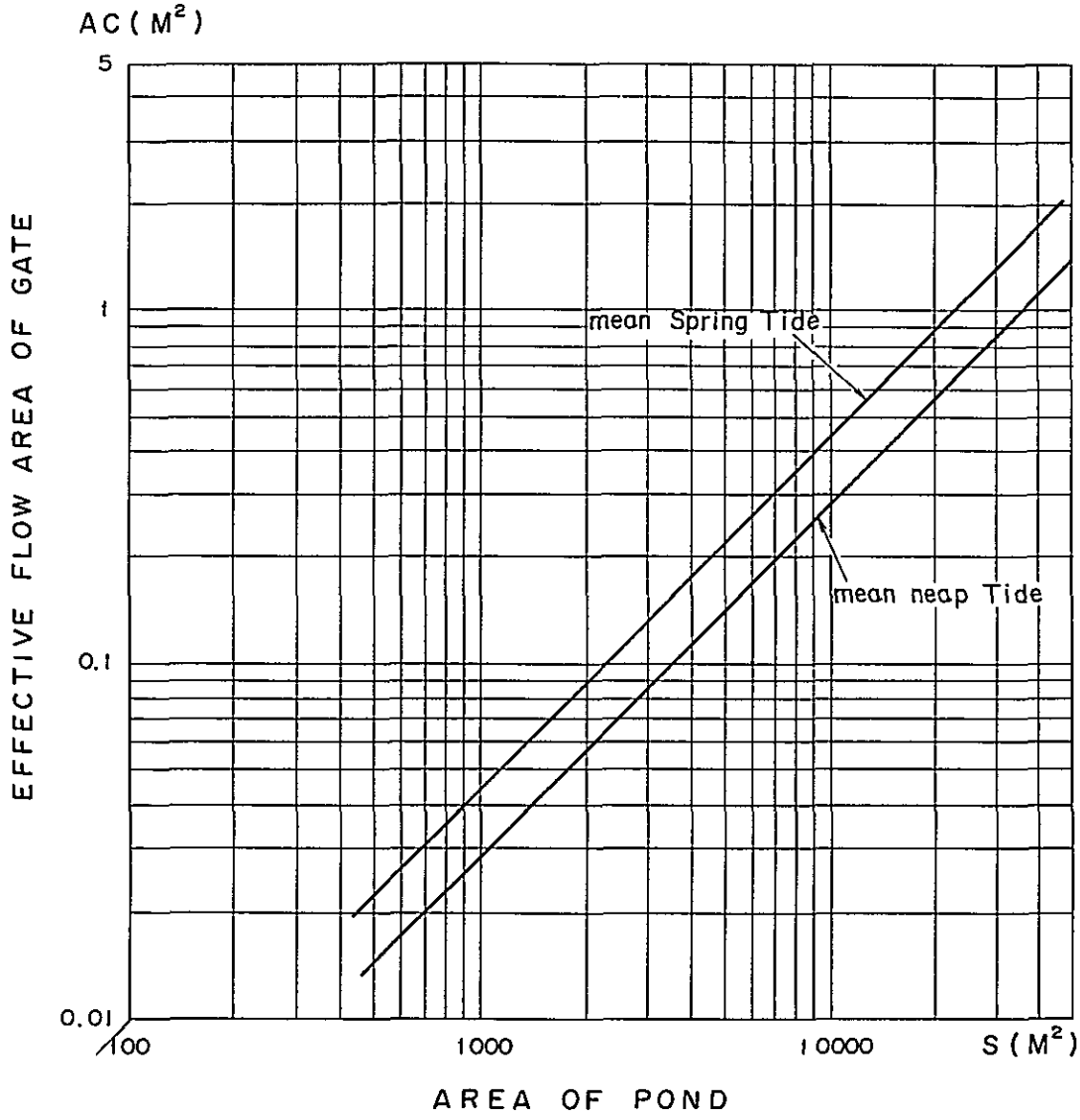


Fig. 23. Diagramatic drawings to illustrate efficient water flows in and out the pond effected by the position of the gate installed and the configulation of the pond. Higher efficiency is expected in the order a to b to c.

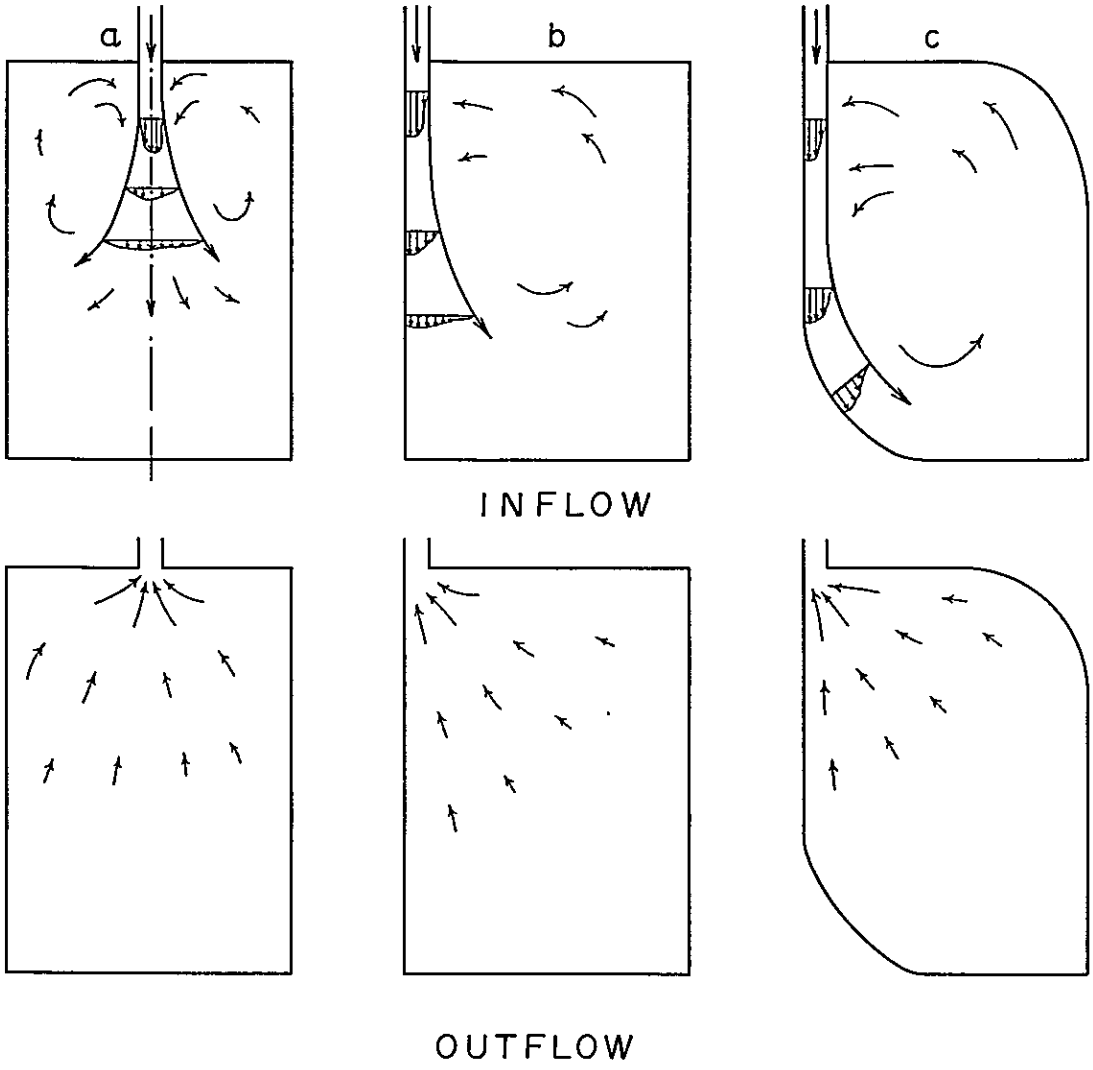


Fig. 24. Diagramatic presentation of the structure of the gate installed to the pond. The general pattern of the structure may be equally applied to the ponds of different sizes. The dimension of culvert pipe and other structures is explained in the text.

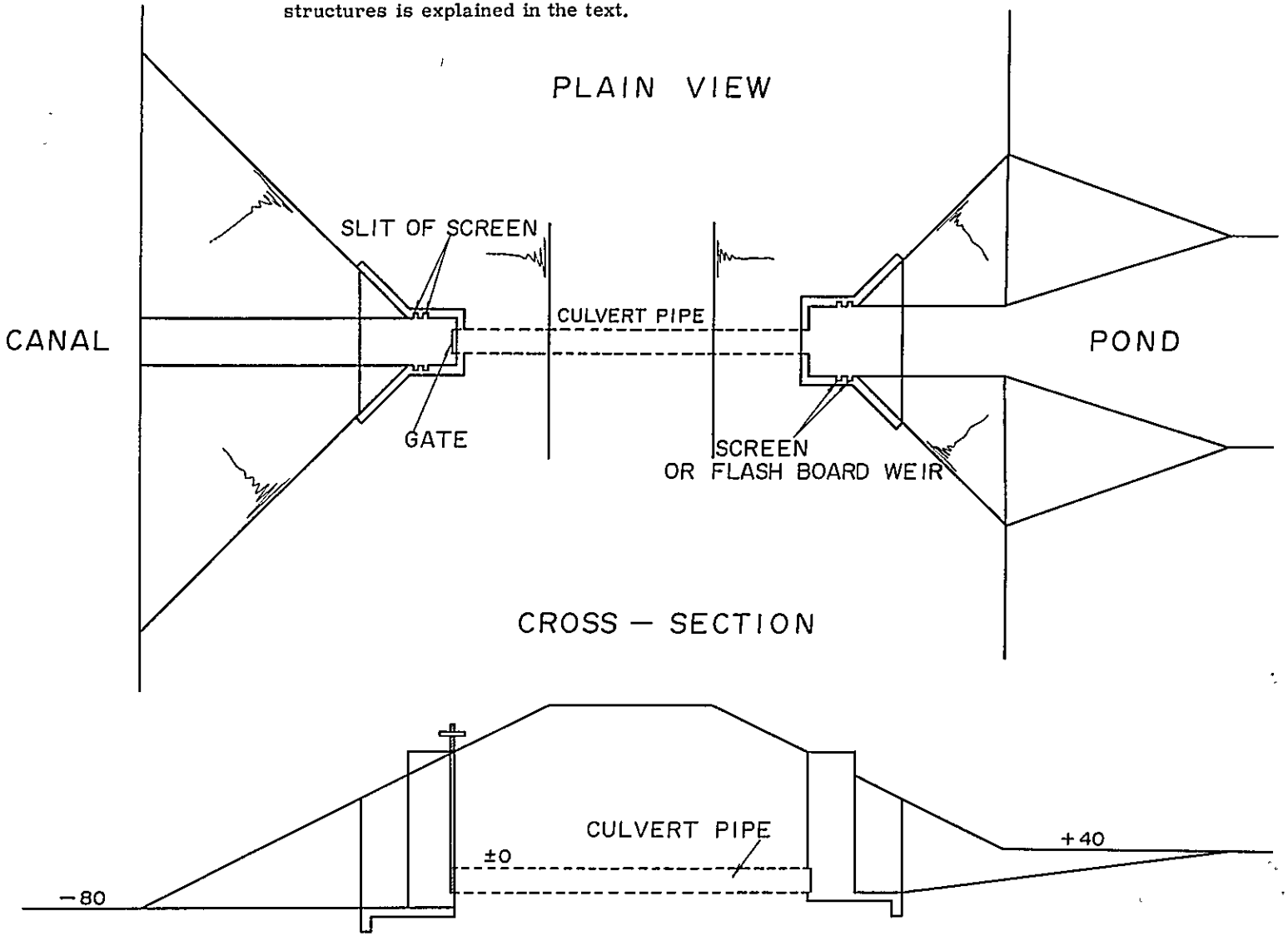


Fig. 25. Layout of the ponds, canals and the irrigation system proposed for the Brackishwater Fish Culture Station under the two projects on the site at Leganes.

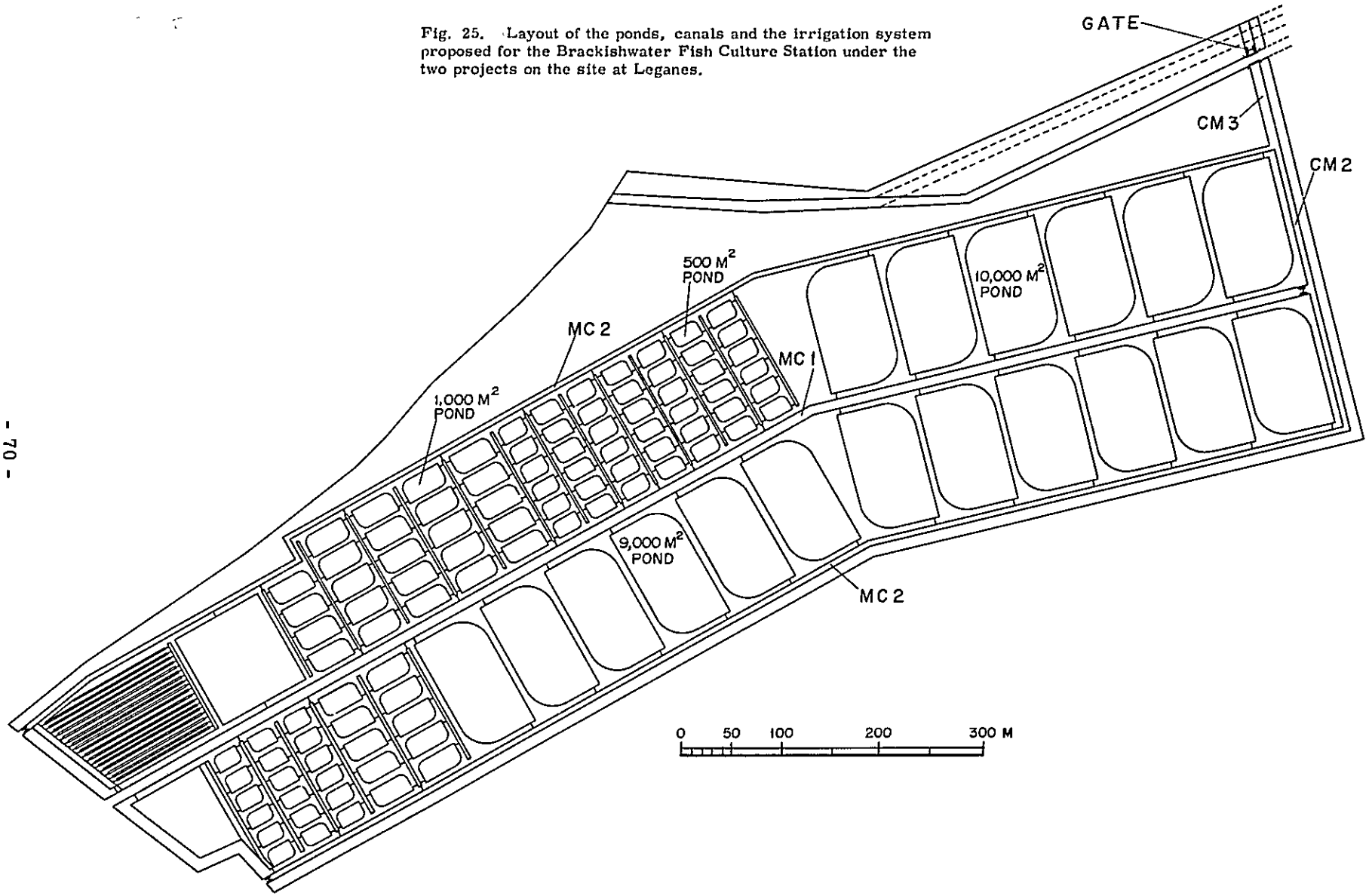


Fig. 26. A graph designed for the conversion from observed S. G. readings to salimity of the water under given temperatures; adopted to the hydrology works by the survey mission to Panay Island (March-April, 1971).

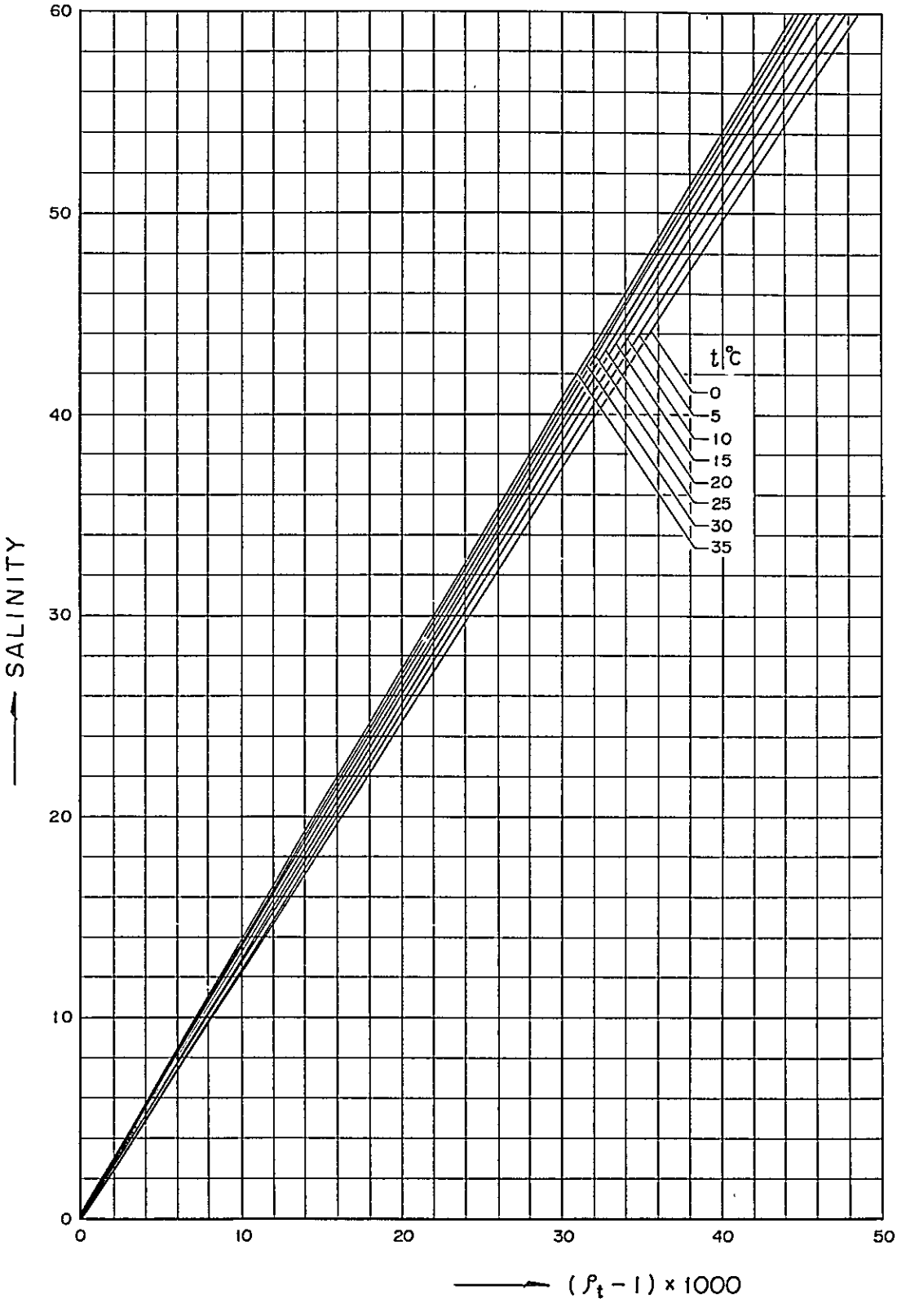


Fig. 27. Graphs constructed from the two formulae (and other notations, see text) showing the relation of water levels outside and inside the pond gate. Upper figure gives the time difference of tidal change outside and inside, and the lower the change of water level in pond according to the area of pond and cross-section of gate. Source : M. Nakamura, "Engineering in aquaculture" (in Japanese), The Kaiyokaihatsu, No. 349 (1970).