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

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN
Tokyo, Japan
January, 1972

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PREFACE

The Overseas Technical Cooperation Agency (OTCA) has the pleasure of presenting the second survey report on the Planning of Brackish Water Fish Culture Station at Leganes, Panay Island, prepared by survey team of four experts headed by Dr. Kuronuma The Team was organized and dispatched to the Republic of the Philippines by the OTCA at the request of the Southeast Asian Fisheries Development Center.

The survey team of experts stayed in the Philippines from August 1 to August 31, 1971 and successfully completed the field survey during wet season including discussion and interview with the authorities concerned, and collection of informations and data with whole-hearted cooperation from the Government of Philippines and other relevant organizations and people.

After their return to Japan, the survey team 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 and people for the generous cooperation and assistance rendered to the study team of experts during their stay.

January 1972

Keiichi Tatsuke
Director General

Overseas Technical Cooperation Agency
Tokyo, Japan

REPORT OF THE SECOND SURVEY FOR THE PLANNING OF BRACKISH WATER FISH CULTURE STATION AT LEGANES, PANAY ISLAND, PHILIPPINES : AUGUST 1-31, 1971[1/] [2/]

(with 13 Tables and 11 Figures)

by THE JAPANESE SURVEY TEAM

CONTENTS

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

2/ The present report also includes in the end MEMORANDUM : BASIC PLAN ON FISH PONDS AND BUILDING OF THE SEAFDEC PROJECT AT LEGANES, PANAY ISLAND, PHILIPPINES, forwarded to Dean, College of Fisheries, University of Philippines, Novenber 26, 1971.

I. INTRODUCTION

During the period from March 11 to April 15, 1971, a Japanese survey team conducted a survey on various natural as well as social conditions required for establishing SEAFDEC Aquaculture Station at Leganes, Panay Island.[1/] Findings of these surveys were presented in the Draft Report of Survey for the Planning of Brackish Water Fish Culture Station at Leganes, Panay Island, Philippines, OTCA, Tokyo: 1072, Figs. 1-27 (June 1971).

Since the above-mentioned first survey was carried out during the dry season, various natural conditions investigated were characteristic only of the dry season, therefore, the survey team felt the need for clarifying the changes in such conditions during the wet season. With this need brought to the attention of the parties concerned, the Overseas Technical Cooperation Agency organized the present second survey team for another survey in Panay Island at the request of the Secretary General of SEAFDEC and with the approval of the Philippine Government.

The present survey was conducted by the following team members during the period from August 1 to 31, 1971.

Members of the Team

Dr. Katsuzo Kuronuma	Leader	Ex-President, Tokyo University of Fisheries
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. Saburo Masai	Secretary	Science Officer, Research Section, Fisheries Agency
Mr. Shigemitsu Takasugi	Coordinator	Procurement Officer, Overseas Technical Cooperation Agency
Mr. Fujio Hayasaka	Coordinator	Administration Officer, Overseas Technical Cooperation Agency
Mr. Takakata Okamoto	Coordinator	Officer, International Cooperation Division, Ministry of Agriculture and Forestry
Mr. Hideo Mochizuki	Technical Assistant	Japan Overseas Cooperation Volunteer

1/ Inthis report, this survey will be called the first survey and present survey the second survey.

Field and laboratory works in Leganes were carried out by all the team members. However, for surveys in specialized fields, Shigeno was assigned for biology, Nakamura for hydrology, Masai for fisheries and Mochizuki took part in all these fields as assistant. The following two counterpart workers from College of Fisheries, University of the Philippines, participated in the survey and offered great help in the surveying, observation, collection and data analysis.

Mr. Edmendo Enderez
Mr. Ramyled Pelayo

Mr. Ambrosio Conlu of the Fisheries Commission (Iloilo Regional Office) who joined the field work also provided the team with various conveniences.

In conducting the survey, the team was greatly assisted by Mr. Tirso Jamandre Jr., who offered his laboratory, Mr. Ernesto V. Jamandre who provided a car and a survey boat, and Mr. Vincento Garibay whose fishing boats were offered for the use of the team. Further, Mr. Arnold P. De Goco made all the arrangements and also acted as the team's guide during the study tour to Mindro Island.

As regards the treatment of materials brought back to Japan, the analysis of insecticides and measurement of plankton were undertaken by Kagoshima Fisheries Experiment Station, while the analysis of sediments was conducted at National Research Institute of Agricultural Engineering.

This report was prepared by four team members each covering their respective specialized fields, with Kuronuma playing the role of overall editing and compilation. The views of all the matters in the report were presented by the team members, and they are not necessarily endorsed by the Govenment authorities concerned of Japan. All the figures contained in the report were prepared by Nakamura who also provided a brief elucidation of the tidal fluctuation and the principles of fish pond design. This elucidation is given as an appendix of the report in the hope that it may serve as a guide to the planning of the Station. Fig. 26 shown in the previous report was amended and presented in this report as Fig. 11.

ACKNOWLEDGEMENTS

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. Especially the survey team wishes to record here the great helps in various ways given by Mr. Ernesto V. Jamandre and Mr. Tirso Jamandre, both Iloilo City, without whose deep understanding to the survey, the present works would have never been conducted so successfully.

II. PROGRESS OF SURVEY

The prime objective of the present survey was to make a detailed review of the results obtained by the first survey and to study what changes take place in the wet season in the natural conditions clarified during the dry season. Therefore, items of actual field survey and observation were almost identical to those covered by the first survey. In addition to these routine works, the present survey included the analysis of agricultural chemicals contained or accumulated in sea water, pond water, sediments and fish body so as to obtain a close understanding of the quality of waters around Leganes, as well as a hydrological survey of sea water which was conducted at Buyuan located 25 km west of Iloilo City for comparison with the result obtained in Leganes.

While interviews were the only source of information on the biology of shrimps during the first survey, a trammel net brought from Japan was used for actual fishing of shrimps during the present survey to obtain actual biological knowledges.

Further, Masai made a trip to Negros Island for a survey on general fishing condition in and around Panay Gulf, and Kuronuma and Shigeno visited Mindro Island for inspection of Mr. de Goco's fish farm.

Prior to its return to Japan, the team had talks for two days with the representatives of the Philippine side during which efforts were made to attain coordination with the Philippine national project and view were exchanged for the progress of the two projects in future.

The Itinerary and General Progress of the Works

1 (Sunday)	Left Haneda Air Port at 12:00 and arrived Manila City at 15:05 hours.
2 (Monday)	Discussion at Embassy of Japan on the programme of the survey and other works attended by 4 persons from Phillipine side.
3 (Tuesday)	Visit to Fisheries Commission and other Offices.
4 (Wednesday)	Visit to Embassy of Japan. Left Manila City at 15:05 and arrived Iloilo City at 16:45 hours.
5 (Thursday)	Visit to Fisheries Commission Office (Iloilo) and the Fish Culture Station. Moving of instruments and tools to the second floor hall, Jamandre Industries, Inc., where temporary Laboratory established.
6 (Friday)	Organization of equipment and tools for ready use. Visit to the Office, Governor of Iloilo Province.
7 (Saturday)	Discussion on the itinerary of surveys and other works planned.
8 (Sunday)	One party field observations on Oton, Tigvauan, Guimbal and Miagao for shrimp fishing and other conditions. One party field work at Leganes site.

9 (Monday)	One party started shrimp fishing at Buyuan. One party field work at Leganes site.
10 (Tuesday)	One party shrimp fishing at Buyuan. One party hydrological survey of the water off Gui-gui Creek.
11 (Wednesday)	One party shrimp fishing at Buyuan. One party 12-hour survey on the waters in Jalaud River and Gui-gui Creek.
12 (Thursday)	Same works as conducted on 11 (Wednesday).
13 (Friday)	One party shrimp fishing at Buyuan. Other party laboratory work.
14 (Saturday)	One party hydrological survey of the water off Gui-gui Creek. One party examination of shrimp fished at Buyuan.
15 (Sunday)	Laboratory work and recording of data.
16 (Monday)	Discussion, laboratory work and recording of data.
17 (Tuesday)	Laboratory work
18 (Wednesday)	One party visiting Bacolod, Negros Island for field survey on shrimp fisheries. One party attending Iloilo Rotary Club luncheon to give a speech; visiting to Asian Foods (Phils) Plant to inspect shrimp storage; examination of shrimp fished at Buyuan.
19 (Thursday)	General survey of fish ponds owned by Mr. E. V. Jamandre at Zarraga.
20 (Friday)	General survey of fish ponds owned by Mr. T. Jamandre at Dumangas.
21 (Saturday)	Discussion and laboratory work.
22 (Sunday)]	Demonstration of equipment and lecture given to the students, Iloilo Regional Fisheries School, visiting the laboratory. One party field survey on Leganes site.
23 (Monday)	12-hour hydrological survey in Jalaud River.
24 (Tuesday)	Checking and packing of equipment and tools in laboratory.
25 (Wednesday)	Deposit of equipment at Department of Botany, University of Philippines, Iloilo City. Left Iloilo City at 16:15 and arrived Manila City at 18:40 hours.
26 (Thursday)	Discussion at Embassy of Japan on the result of survey and programme for following days.
27 (Friday)	Meeting between survey team and persons from Philippine side.
28 (Saturday)	One party observation tour to fish pond owned by Mr. Goco, Sinaoga Island, Mindro.
29 (Sunday)	Visit to fish pond owned by Mr. Lerma, Manila City.
30 (Monday)	Meeting between persons of Japanese and Philippine sides at D. & E. Building, Manila City.
31 (Tuesday)	Left Manila City at 13:30 and arrived Haneda Air Port at 20:00 hours.

Persons contacted during the second survey trip to the Phillipnes

ANDRES M. MANE	Commissioner, Fisheries Commission
PEDRO A. ACOSTA	Staff, ditto
ROGELIO O. JULIANO	Dean, College of Fisheries, University of Philippines
MELCHOR M. LIJAUCO	Instructor, ditto
JOSE A. CARREON	Director, Institute of Fisheries Development and Research, University of Philippines
VIGILIO A. DUREZA	Researcher, ditto
EDMENDO ENDREZ	ditto
RAMYLED PELAYO	ditto
ROBERTO E. FRONDA	Executive Director, National Food and Agriculture Council
MAURO E. AMUTAN	Staff, ditto
MAXIMO G. RAMOS	ditto
ELVIRA O. TAN	Fisheries Officer, National Science Development Board
FRANK SHEPPARD	Director, United States Agency for Development Development
RAYMOND COHEN	Staff, ditto
DONALD YEAMAN	ditto
DAVID S. NAVARRO	Staff, National Science Development Board
CRESENCIANO L. BAYANI	Project Manager, Amalgamated Project Management Service, Inc.
CESAR LOPEZ	Engineer, ditto
AMBRESIO ROBRICADO	ditto
ARNOLD I. DE GOCO	President, Sinaoga Fishpond, Inc.
CONCORDIA P. DE GOCO	Vice-President, ditto

BENJAMIN E. LERMA	President, Lerma, Inc.
TOSHIO URABE	Ambassador of Japan
MISAO YAMASAKI	Councellor, Embassy of Japan
KAZUHIRO MATSUSHITA	Second Secretary, ditto
KUNIO TAKASE	Agricultural Engineer, Asian Development Bank
V. M. NAIR	Fishery Specialist, ditto
VERNACIO ALIGAEN	Professor, University of Philippines (Iloilo)
ELPIDIO M. ICAMINA	Superintendent, Iloilo Regional School of Fisheries
LOURDES A. DREZA	Instructor, ditto
CESAN ALILIS	Director, Fisheries Commission Regional Office (Iloilo)
AMBROSIO CONLU	Staff, ditto
ERNESTO V. JAMANDRE	President, Jamandre, Inc.
TIRSO JAMANDRE	President, Jamandre Industries, Inc.
J. MANUEL LEZAMA	Manager, Asia Foods (Phils) Corp.
MITSUO NISHIMURA	Staff, ditto
PEDRO G. PADLAN	Director, Philippine Research Society on Fish Culture
ADOLFO E. JAEN	Mayor, Leganes Municipality
CONRAD J. NORADD	Governor, Iloilo Province
VINCENTO GORIBAY	President, Goribay Fishing, Inc.
YUKINORI SANO	Japan Overseas Cooperation Volunteer
HIDEO MOCHIZUKI	ditto

III. SURVEY CONDUCTED AND THE RESULTS

1 Sources of waters at Leganes, studied during wet season

The hydrological survey in Leganes was conducted at the same place and by the same method as adopted during the first survey.

The observed values of the water level, temperature, pH and salinity of the Gui-gui Creek and the Jalaud River are shown in Table 1 and also illustrated in Fig. 1 and 2. The tidal curve shown in Fig. 1, which was prepared from the data of Cebu port as explained in the report of the first survey, shows close approximation to the observed value. In other words, the figure shows that the calculated values of tidal level on Leganes coast conform to the observed values. This leads to the conclusion that the tidal characteristics obtained by the first survey can be considered correct, and further the bench mark level determined on the basis of the said characteristics can also be regarded correct. The water level of the Jalaud is somewhat lower in range than that of the Gui-gui Creek, and this is believed assignable to the flow of water in the former.

Table 1. Record of the 12-hour continuous observations in the Gui-gui Creek and Jalaud River on the level, temperature and salinity of the waters conducted on August 11, 1971.

Gui-Gui Creek					Jalaud River						
Time (hr)	Level (cm)	Temp. (°C)	pH	Sal. (‰)	Time (hr)	Level (cm)	Temperature (°C) Surface	Temperature (°C) Bottom	pH	Salinity (‰) Surface	Salinity (‰) Bottom
0800	15	29.0	8.29	21.6	0800	25	30.4	29.5	7.82	0.2	0.2
0815	13				0815	24					
0830	15	28.8		21.5	0830	23	29.1	29.1		0.2	0.2
0845	20				0845	22					
0900	23	29.4	8.23	19.8	0900	24	29.0	29.0	7.82	0.2	0.2
0915	24				0915	25					
0930	30	29.9		20.6	0930	30	29.7	29.5		0.2	0.2
0945	39				1000	34	29.7	29.5	7.78	0.2	0.2
1000	43	30.5	8.30	20.2	1030	43	29.0	29.1		0.2	0.2
1030	58	33.2		21.7	1100	50	29.0	29.2	7.97	0.2	0.2
1100	78	32.0	8.38	20.5	1130	81	29.1	29.1		0.2	0.2
1130	97	31.5		26.5	1200	102	29.6	29.4	7.90	0.2	0.2
1200	119	31.5	8.33	23.8	1230	126	29.5	29.2		0.2	0.2
1230	139	32.0		29.6	1300	145	29.4	29.2	7.71	0.2	0.2
1300	156	32.0	8.40	27.4	1330	161	30.1	29.1		0.2	11.8
1330	167	32.8		26 4	1400	166	29.6	29.1	7.77	0.2	18.4
1400	173	32.4		24 1	1415	168					
1415	176				1430	170	30.0	29.1		0.2	23.1
1430	175	32.5	8.38	27.3	1445	167					
1445	170				1500	162	29.2	29.2	7.61	0.2	0.2
1500	164	32.4	8.37	27.4	1515	155					
1530	153	31.2		23.4	1530	149	29.1	29.4		0.2	0.2
1604	132	31.0	8.40	23.9	1600	132	30.7	30.4	7.87	0.2	0.2
1630	118	30.7	8.47	23.1	1630	116	29.8	30.0		0.2	0.2
1700	99	30.4	8.48	22.1	1700	101	29.9	30.4	7.79	0.2	0.2
1730	82	29.5		21.3	1730	84	29.6	30.2		0.2	0.2
1800	67	29.0	8.47	22.1	1800	70	29.5	30.2	8.11	0.2	0.3
1830	48	28.9		23.4	1830	56	29.8	30.2		0.2	0.2
1900	41	28.5	8.45	23.2	1900	45	29.3	30.3	8.42	0.2	0.2
1930	25	28.2		22.7	1930	36	29.2	30.2		0.2	0.2
1947	19				1945	31					
1959	16	28.0	8.48	22.5	2000	27	29.4	30.0	8.21	0.2	0.2
2016	15				2015	24					
2028	13	28.0		22.2	2030	22	29.0	29.9		0.2	0.2
2045	12				2045	20					
2054	11				2100	19	29.0	29.2	8.12	0.2	0.2
					2115	18					

As regards the relationship between the tidal range and the flow of water of the river, the following results were obtained by a simultaneous observation of the both carried out on August 23.

The water level, temperature and salinity were observed at a point immediately downstream of BM1, and the flow of water at a fixed station approximately 700 m upstream of the said point. Results of these observations are shown in Tables 2 and 3, and their data are illustrated in Fig. 3 and 4.

Table 2. Record of the 14-hour continuous observation of the level, temperature and salinity of the water in the Jalaud River in front of the BM 1 from 0700 to 2030 hours, August 23, 1971.

Time (hr)	Level (cm)	Temperature (°C) Surface	Bottom	Salinity (‰) Surface	Bottom
0703	26				
0715	27				
0730	30	29.4	29.4	0.2	0.2
0745	36				
0800	40	29.2	29.2	0.2	0.2
0815	46				
0830	50	29.8	29.8	0.2	0.2
0845	55				
0900	61	29.2	29.4	0.2	0.2
0930	83	29.8	29.7	0.2	0.2
1000	102	29.4	29.4	0.25	0.25
1030	123	29.8	29.3	0.4	11.9
1100	146	29.8	29.0	1.45	22.5
1115	158				
1130	167	30.6	29.0	2.1	26.5
1145	175				
1200	182	30.6	28.85	2.2	28.4
1215	188				
1230	189	30.4	29.0	2.9	29.0
1245	192				
1300	191	31.5	29.2	1.4	27.8
1330	178	30.2	29.9	2.6	25.7
1400	163	29.7	30.0	4.3	15.6
1430	149	29.8	30.0	3.95	4.55
1500	130	30.0	30.2	3.8	4.8
1530	109	30.2	30.3	4.1	4.05
1600	93	31.0	30.6	4.05	4.3
1630	77	29.9	30.1	2.6	2.6
1700	64	29.6	29.9	1.7	1.45
1730	48	29.6	29.8	0.5	0.5
1800	36	29.4	29.8	0.3	0.3
1815	32				
1830	76	29.3	30.1	0.2	0.2
1845	20				
1900	17	29.5	29.7	0.2	0.2
1915	14				
1930	10	29.2	29.4	0.2	0.2
1945	8				
2000	7	29.6	29.9	0.2	0.2
2015	7				
2030	8				

Table 3. Record of the 14-hour continuous observations at the station (see text) in the Jalaud River on the velocity, level of the water and discharge observed and calculated. August 23, 1971.

Time (hr)	Depth (cm)	Velocity (m/sec)	Mean velocity (m/sec)	Elevation (m)	Flow area (m^2)	Discharge (m^3/sec)
	0	0.225				
0815	50	0.192				
	100	0.205	0.208	0.42	151	31.408
	150	0.205				
	200	0.215				
	250	0.204				
	300	0.165				
	320	0.204				
	0	0.158				
0910	50	0.158				
	100	0.192	0.121	0.67	156	18.871
	150	0.121				
	200	0.163				
	250	0.100				
	300	0.103				
	350	0.056				
	365	0.040				
	0	-0.040				
1010	50	-0.117				
	100	-0.103	-0.090	1.07	196	-17.64
	150	-0.148				
	200	-0.079				
	250	-0.103				
	300	-0.084				
	350	-0.080				
	365	-0.062				
	0	-0.132				
1115	50	-0.159				
	100	-0.100				
	150	-0.126	-0.187	1.58	235	-43.945
	200	-0.103				
	250	-0.092				
	300	-0.082				
	350	-0.441				
	400	-0.373				
	450	-0.348				
	470	-0.103				

	0	-0.079				
1200	50	-0.055				
	100	-0.055				
	150	-0.062	-0.113	1.86	256	-28.928
	200	-0.204				
	250	-0.199				
	300	-0.181				
	350	-0.119				
	400	-0.135				
	450	-0.045				
	0	0.419				
1310	50	0.374				
	100	0.363				
	150	0.338				
	200	0.064	0.194	1.87	256	49.664
	250	0.121				
	300	0.022				
	350	0.075				
	400	0.107				
	420	0.54				
	0	0.570				
1345	50	0.514				
	100	0.479				
	150	0.480	0.329	1.74	247	81.263
	200	0.408				
	250	0.100				
	300	0.092				
	350	0.189				
	365	0.129				
	0	0.568				
1410	50	0.466				
	100	0.418				
	150	0.389	0.374	1.59	236	88.264
	200	0.389				
	250	0.242				
	300	0.132				
	350	0.193				
	400	0.108				
	425	0.044				
	0	0.596				
1440	50	0.453				
	100	0.387				
	150	0.346	0.374	1.42	223	83.402
	200	0.338				
	250	0.342				
	300	0.418				
	350	0.285				
	400	0.360				
	430	0.220				

1510	0	0.530	0.4277	1.23	209	89.243
	50	0.514				
	100	0.474				
	150	0.468				
	200	0.468				
	250	0.437				
	300	0.412				
	350	0.372				
	400	0.173				
1535	0	0.460	0.386	1.05	195	75.27
	50	0.463				
	100	0.443				
	150	0.444				
	200	0.445				
	250	0.406				
	300	0.333				
	350	0.262				
	370	0.220				
1608	0	0.379	0.394	0.90	184	72.496
	50	0.395				
	100	0.381				
	150	0.382				
	200	0.394				
	250	0.408				
	300	0.422				
	345	0.410				
1639	0	0.483	0.4195	0.72	171	71.649
	50	0.444				
	100	0.435				
	150	0.411				
	200	0.382				
	250	0.398				
	300	0.423				
	320	0.380				
1708	0	0.468	0.408	0.58	161	65.688
	50	0.418				
	100	0.419				
	150	0.412				
	200	0.400				
	250	0.396				
	300	0.391				
	320	0.360				
1738	0	0.414	0.371	0.44	152	56.392
	50	0.409				
	100	0.397				
	150	0.367				
	200	0.420				
	250	0.377				
	300	0.268				
	316	0.316				

1806	0	0.389	0.3735	0.32	145	53.650
	50	0.381				
	100	0.389				
	150	0.365				
	200	0.349				
	250	0.380				
	300	0.362				
1836	0	0.383	0.3617	0.23	139	50.179
	50	0.380				
	100	0.362				
	150	0.366				
	200	0.353				
	250	0.338				
	290	0.300				
1908	0	0.363	0.336	0.14	133	44.688
	50	0.345				
	100	0.323				
	150	0.327				
	200	0.335				
	250	0.348				
	290	0.311				
1936	0	0.355	0.330	0.09	131	41.250
	50	0.343				
	100	0.333				
	150	0.315				
	200	0.350				
	250	0.307				
	280	0.308				
2007	0	0.367	0.315	0.07	129	40.635
	50	0.317				
	100	0.323				
	150	0.308				
	200	0.308				
	250	0.315				
	285	0.268				

The characteristic flow (or flow of freshwater) of the Jalaud River on August 23, as obtained from Fig. 4, is 35.5 m^3/sec. The mean difference of level (ΔH) between the Leganes coast and the Jalaud (at BM 1) can be calculated as follows by the application of formula (5) employed in the first survey report (p. 18).

$$H = 2.5 \times 10^{-5} \times 35.5^2 + 0.065 = 0.097 \text{ m}$$

The calculated tidal range at this time at the river mouth is 1.83 m in rising tide and 2.10 m in falling tide, and the mean tidal range (ζo) is 1.97 m. The calculated tidal period (T) is 12 hours 49 minutes. Employing Fig. 7 shown in the first survey report (p. 55), the following calculation can be established.

$$\frac{\zeta o}{gT^2} = \frac{1.97}{9.8\,(769 \times 60)^2} = 9.45 \times 10^{-11}$$

$$\frac{\zeta R}{\zeta o} = 0.98 \qquad \therefore \zeta R = 1.93$$

$$\frac{\Delta T}{T} = 0.032 \qquad T \doteq 25 \text{ min}$$

Shown below is a comparison between these calculated values and the observed values (Fig. 3).

		Calculation	Observation	Correction
Tidal range ζR		1.93 m	1.78 m	1.78/1.93 = 0.92
In low tide	Cebu	6.03		
	Leganes	6.55		
	The Jalaud (at BM 1)	7.20	7.00	
In high tide	Cebu	12.21		
	Leganes	12.31		
	The Jalaud (at BM 1)	12.56	12.50	
In low tide	Cebu	18.52		
	Leganes	19.44		
	The Jalaud (at BM 1)	20.09	20.07	

As will be understood from the above comparison, the observed values of tidal period shows a fair conformity to the calculated values, whereas the observed tidal range, which is affected by water flow, is lower than the calculated value.

Due to the lack of accurate data on flow of water, the effect of water flow on tidal range was not studied during the first survey, but this problem was brought to a solution by the present survey.

The observation of the Jalaud conducted on August 11 (See Fig. 2) disclosed that the mean head of level (ΔH) is approximately 0.17 m. By referring to Fig. 9 shown in the first survey report (p. 56), the flow at the time of the said observation can be discovered to be 64 m^3/sec, so that the corrected value of tidal range turns out to be 0.86. Accordingly, the approximate value of the corrected tidal range (α) of the Jalaud can be calculated as follows.

$$\alpha = 1.0 - 0.0022\, q \qquad \text{(a)}$$

For the sake of reference, the calculation method of the level of the Jalaud is explained in the following items.

(1) The tidal level and tidal period are to be obtained from the standard Tide Table.

(2) The mean water level on the Leganes coast is to be obtained from the mean water level of Cebu by 1.29, and then applying the products obtained to Leganes. The values of tidal period on the Leganes coast are:(high tide time at Cebu + 11 minutes) and (low tide time at Cebu + 52 minutes).

(3) Values of ζR and ΔT are to be obtained from Fig. 7 shown in the first survey report (p. 55), with the tidal range on the Leganes coast taken at ζ_o. The tidal range of the Jalaud at BM 1 can be obtained from water flow (q) by the application of equation (a). The mean head difference (ΔH) between the coast and BM 1 can be calculated by the following equations.

$$(M.W.L.)_{Jalaud} = (M.W.L.)_{Leganes} + \Delta H$$

$$\zeta_{Jalaud} = \alpha\, \zeta R$$

$$t_{Jalaud} = t_{Leganes} + \Delta T$$

where, M.W.L. denotes mean water level, ζ tidal range and t tidal period.

2 Coastal Waters at Leganes and Buyuan referring to Shrimp Hatchery Operation

The operation of the Leganes Station under the SEAFDEC's project will be intended primarily for the training and research activities for shrimp culture in the initial stage. As the Station is expected to train and supply technicians who can offer practical service in the planned shrimp culture, both the curriculum and facilities for the training should be planned to amply meet this purpose. From this viewpoint, the team made studies on the type of facilities to be established at Leganes site and presented an overall plan of shrimp culture pond in its first report. As stated in this first report, however, one of the major tasks assigned to the second survey team was to make studies for establishing a fundamental approach to the production or supply of larvae at Leganes site because this is a prerequisite to the shrimp culture though the culture in the pond undoubtedly constitutes an important part of the shrimp culture operation program. Accordingly, the team was required to draw up a concrete plan which fits into the situation in Leganes and promises the production or supply of larvae at the site. As a means to obtain larvae for shrimp culture, the following two methods are available.

(1) Method in which naturally grown young shrimps (post-larva or juvenile) are caught and supplied (Natural method).

(2) Method in which sexually matured female shrimps are caught for spawning in the on-land water tanks, and hatched larvae are reared concentrically until they grow to post-larvae. (Artificial method).

The natural method adppted in the project area can be briefed as follows.

During the wet season generally lasting from June to October, multitude of natural seed shrimps (P. monodon) gather near the beach extending from Iloilo to Oton, Tigbauan, Guimbal and Miagao as well as in neighbouring rivers and creeks. These natural shrimp larvae are caught as the seed. These places can be reached by 30 min. to 1 hour drive from Leganes, and the annual catch of the seed shrimps, as obtained through interviews with local people, seems suffice for the training and research purposes at present.

In the Philippines, however, there are very few areas where the problem of larva supply can be solved simply by catching the abundant natural seed shrimps near the pond and stocking them in the pond. Such areas are even more limited in number in the entire Asian region. Further, the areas favoured with abundant availability of natural seed shrimps are not, as a matter of fact, exempt from the annual catch fluctuation and from the instability of the demand-supply balance invited in the long-run from the changes in environments and economic conditions. These problems confront all the domestic enterprises occupying themselves with culture of shrimps. Solution can be brought to these problems if the techniques developed in Japan for bulk larva production of Penaeus japonicus, P. latisulcatus, P. orientalis, and P. semisulcatus are introduced into the project area, particularly for breeding of species like P. monodon, P. merguiensis and P. indicus which abound in the project area. Virtually all the Philippine owners of shrimp ponds contacted by the team expressed the strong hope for the construction of a hatchery and stable and bulk larva supply therefrom as well as for the training and extension of the necessary techniques. The larva breeding is not only an essential ingredient of the future development of shrimp culture in the project area, but also bears closely upon the pond culture operation in the whole of Southeast Asian region.

For reasons given above, the team recommends that SEAFDEC's Aquaculture Department introduce the bulk larva production techniques of shrimps as one of its functions and also establish the necessary facility (hereafter called the "hatchery"). It leaves no doubt that a high operational efficiency can be attained if a hatchery is built at Leganes site. By reason of the hydrological and geographical environments at the site, however, whether a hatchery constructed at the site would be technically capable of fully exhibiting its performance has been a subject left for the team for further study since the first survey.

The following are the minimum technical requirement that must be satisfied for the hatchery construction.

(1) Clean sea water having stabilized quality can be readily pumped up at the construction site in large volume both at present and in future.

(2) Sexually matured female shrimps can be obtained near the construction site in sufficient amount as required.

(3) Fresh water of good quality needed in daily life, laboratory work and miscellaneous works can be readily obtained at the construction site.

Sea water used for hatching and rearing of shrimps should have an extremely small content of suspending matters such as muddy particles and dirts when visually inspected, and should preferably be clear enough to cause no clogging to a Mullergaze No. 15 plankton net after filtering about 100 tons. It is also desirable that it is coastal sea water containing an adequate percentage of nutritive salts which accelerate the growth of diatoms. Sea water containing excessive nutrients which give rise to frequent red tide development, subjected to organic contamination, or containing too much bacteria or protozoa should not be used since it often gives a vital blow on shrimps in the early larval stage.

The validity of the plan to construct a hatchery at Leganes site can be judged by whether the sea water in its vicinity satisfies the above conditions. From the findings of the hydrological survey carried out during the first survey, however, the team had a very pessimistic view about the sea water condition near Leganes site. The present survey was conducted in the presumed peak spawning period of P. monodon in order to make this point clear and arrived at a conclusion and also to tackle the problem of the seed shrimps supply. The team also observed the coast of Panay Gulf extending to St. Jaquin located west of Iloilo City, and sampled sea water off Buyuan Balio of the Municipality of Tigbauan and tested its quality on the same items as covered for the sea water near Leganes site. Visits to these places were intended to serve the dual purpose of finding suitable alternative sites by reason of the possible technical difficulty in constructing a hatchery at Leganes site and making a study on the supply of seed shrimps. The coast line of Panay Gulf presents a rather simple configuration. Assuming, therefore, that the coastal water in this area is generally uniform in quality except in the estuary, a point off the coast of Buyuan Balio was arbitrarily selected for observation (See Fig. 4). This point, about 25 km from the centre of Iloilo City, faces the outer sea, so that it is located quite opposite to Leganes which extends from Iloilo Strait towards the inner sea.

On August 10 and 12, observation was made on the position, depth, transparancy, salinity, temperature and pH value at both falling and rising time at respective stations in Gui-gui Creek and Leganes. Results of this observation are shown in Tables 4 and 5 and Figs. 6 and 7.

Table 4. Record of the hydrological survey at the 12 stations (see Fig. 6) in the Gui-gui Creek and shore water off the creek estuary conducted from 16:00 to 18:30 hours (falling tide), August 10, 1971.

Station		Time (hr)	Depth (m) Sounding	On D. L.	Temperature (°C)	Salinity (‰)	pH	Transparency (m)
1	Surface	1830	1.6	+1.21	29.4	23.7	8.78	Nil
	Bottom				29.6	28.5	8.70	
2	S	1756	1.6	+0.97	29.6	25.1	8.67	0.6
	B				29.8	28.1	8.69	
3	S	1743	1.8	+1.07	29.5	27.1	8.71	0.6
	B				29.6	28.7	8.63	
4	S	1600	1.0	+0.47	30.0	29.4	8.60	0.8
	B				30.0	30.2	8.44	
5	S	1624	1.9	+0.62	29.6	29.4	8.61	0.9
	B				29.4	31.1	8.58	
6	S	1635	1.1	-1.0	29.2	30.9	8.62	1.0
	B				29.3	31.3	8.62	
7	S	1645	1.1	-0.05	29.4	29.9	8.62	0.8
	B				29.6	31.2	8.61	
8	S	1653	1.1	+0.03	29.2	31.0	8.63	1.0
	B				29.4	31.1	8.64	
9	S	1701	1.2	+0.19	28.6	30.7	8.62	1.1
	B				29.0	31.5	8.62	
10	S	1711	1.1	+0.15	29.4	30.4	8.62	0.8
	B				29.5	29.1	8.63	
11	S	1720	1.2	+0.31	28.6	31.0	8.60	0.9
	B				28.6	31.1	8.59	
12	S	1726	2.5	+1.65	28.0	31.92	8.59	0.9
	B				28.1	29.8	8.55	

Table 5. Record of the hydrological survey at the 12 stations (see Fig. 7) in the Gui-gui Creek and shore water off the creek estuary conducted from 09:22 to 11:12 hours (rising tide), August 12, 1971.

Station		Time (hr)	Depth (m) Sounding	On D. L.	Temperature (°C)	Salinity (‰)	pH	Transparency (m)
1	Surface	0922	2.06	+1.98	31.0	25.3	8.41	0.6
	Bottom				30.6	26.1	8.42	
2	S	0933	1.90	+1.80	29.4	26.5	8.48	0.55
	B				29.2	25.7	8.39	
3	S	1000	1.40	+1.24	31.4	27.0	8.42	0.4
	B				30.8	28.1	8.40	
4	S	1008	0.60	+0.41	30.4	28.6	8.47	0.5
	B				30.4	29.9	8.45	
5	S	1016	0.60	+0.37	31.1	30.0	8.46	bottom
	B				31.5	30.5	8.51	
6	S	1026	0.50	+0.24	30.2	31.3	8.49	bottom
	B				30.2	31.3	8.50	
7	S	1032	0.50	+0.22	30.0	31.5	8.51	bottom
	B				30.0	31.4	8.51	
8	S	1040	0.80	+0.47	30.3	31.1	8.50	0.7
	B				30.3	31.1	8.50	
9	S	1049	0.70	+0.34	29.4	31.5	8.50	0.6
	B				29.4	31.5	8.50	
10	S	1056	1.90	+1.46	29.8	31.2	8.50	0.55
	B				29.4	31.4	8.50	
11	S	1103	8.00	+7.55	29.9	31.2	8.50	1.15
	B				28.6	31.5	8.49	
12	S	1112	2.10	+1.60	29.4	31.6	8.51	0.55
	B				29.4	31.6	8.51	

The observed values of depth indicate that the sea in the project area is shallow for a great distance from the shore. The team learned from the local pond owners that when sea water recedes at time of low water level of spring tide, the dried up shoal exposes itself for a distance of about 1 km from the shore, allowing only a narrow channel from the creek to the offing to maintain a depth required for the navigation of small boats. Reclamation work is now in progress in the shallow sea area on the east of the survey line shown in the Fig. 6 for creation of a new fish pond.

Observation of transparancy using a Secchi disk revealed that the water turbidity increases conspicuously at rising time, with a transparancy recording no higher than 40 to 60 cm. Though the transparancy improves at falling time, it was observed to be only about 1 m. The suspending muddy particles are the cause of this heavy turbidity.

Salinity at stations, 1, 2 and 3 and at station 4 which is closest to the shore is lower than at the off shore stations, and is also subjected to a large fluctuation caused by tide condition. Hence, it is unstable and ranges from the lowest of 24 ‰ to the highest of 30 ‰. Temperature and pH value, however, show an approximately uniform distribution.

Data of the present survey indicate, when compared with those of the first survey conducted on March 26, 1971, a noteworthy decline of transparency, some salinity drop observed at most stations and a sharp salinity drop in Gui-gui Creek, and a rise of temperature by about 3°C noticed at most stations.

Observation of all the above-mentioned items was also conducted off Buyuan Balio, of which the results are shown in Table 6 and Fig. 8.

Table 6. Record of hydrological survey at the 13 stations (see Fig. 8 in the coastal water off Buyuan, Tigbauan Municipality, Iloilo Province, Panay Island. August 14, 1971.

Station		Time (hr)	Depth (m) Sounding	Depth (m) On D L	Temperature (°C)	Salinity (‰)	pH	Transparency (m)	Sediment
1	Surface	0943	0.8	+0.335	29 8	31.6	8.72	bottom	Sandy, rather dark
	Bottom				29.6	32.1	8 72		
2	S	0952	3.5	+3.237	29 9	32.1	8.72	1 9	"
	B				29.4	30 7	8.73		
3	S	1000	3.7	+3.305	29.1	32.34	8.72	2.2	Silty loam, brownish
	B				28.8	32 40	8.72		
4	S	1010	3 6	+3 24	29.0	32.41	8 76	2.1	Sandy, rather dark
	B				28 7	32 54	8 72		
5	S	1020	4.05	+3.71	28.9	32 5	8 76	2.3	Sandy loam, dark
	B				28 6	32.2	8.77		
6	S	1025	5 75	+5 42	29.0	32.40	8 74	3 0	"
	B				28.6	32.52	8.78		
7	S	1035	7.0	+6 7	30.7	31.9	8.76	3.6	"
	B				29.8	32 1	8.77		
8	S	1045	8.4	+8.12	29.2	32.4	8 77	4.2	Sandy loam; brownish
	B				28.6	32.15	8.77		
9	S	1052	9.5	+9.24	29.2	32.33	8.80	3.4	Silty loam; brownish
	B				28.6	32.45	8.79		
10	S	1100	11.2	+10.95	29.8	32.15	8.77	4 1	Silty clay loam; brownish
	B				29.4	32.25	8.78		
11	S	1115	10.9	+10.68	30.4	31.6	8.78	3.7	Silty loam, brownish
	B				29 9	31.9	8.78		
12	S	1125	12.1	+11.89	29.2	32.25	8 78	3.3	"
	B				28.6	32.55	8.78		
13	S	1145	40.0	+39.8	29 5	32.35	8.78	3.3	(not available)
	B				27.6	33.25	8.73		

As shown in Fig. 8, a depth of more than 3 m was recorded for a distance of 100 m from the beach, and farther from this 100 m distance, the sea bottom becomes gradually deeper with a very mild slope. The bottom soil is sand or mud presenting dark or brownish gray colour. The results of grain analysis conducted on the sediments (bottom soil) at this place are compared with the findings in Gui-gui Creek in Table 7 and Fig. 9. In general, the bottom soil of Gui-gui Creek is muddy and that off the Buyuan coast is sandy. This fact conforms to the trend of suspending matters, transparency, bacterial count, BHC and DDT contents observed at the two places, and it is evident that the sea water in the creek is more polluted.

Table 7. Analyses of the sediment in the Gui-gui Creek and the sea coast at Buyuan, Tigbauan Municipality collected on 10 and 14 August, 1971 respectively. For the position of each station where the materials were sampled in the two regions, see Fig. 6 and 8. Figures on the right 3 columns show the mesh size of sieves interpolated from Fig. 9.

Region and	Station	Incandescent reduction (‰)	Size and amount of grain: Maximum (mm)	% of material passing sieves: 60	30	10
Gui-gui Creek	1	11.4	0.105	0.011	0.0022	-
	2	5.7	4.76	0.700	0.32	0.011
	3	10.8	0.84	0.019	0.0043	-
Buyuan sea coast	1	2.6	2.0	0.180	0.130	0.085
	2	4.3	2.0	0.210	0.140	0.060
	3	7.4	0.42	0.053	0.018	0.002
	4	5.1	0.84	0.200	0.120	0.038
	5	4.8	0.84	0.130	0.070	0.022
	6	4.4	0.42	0.100	0.065	0.020
	7	6.3	0.42	0.090	0.050	0.005
	8	8.2	2.0	0.160	0.013	0.001
	9	7.1	0.42	0.039	0.016	0.002
	10	7.1	0.42	0.050	0.008	0.002
	11	5.9	0.42	0.064	0.037	0.006
	12	7.0	0.42	0.057	0.026	0.003

The bottom soil at Stations 1 and 3 in Gui-gui Creek may be classified as silty clay. Unlike these two stations, Station 2 produces sandy bottom soil, and this may perhaps be ascribable to the effect of water current because this station is located immediately downstream of the canal gate.

Buyuan coast produces sediments considerably differing from each other by station, suggesting the complexity of ocean current and tidal current along the coast. If the sediments of this coast are to be classified by grain size, Stations 1, 2 and 4 may be considered sandy, Stations 5, 6, 7 and 8 sandy loam, Stations 3, 9, 11 and 12 silty loam, and Station 10 silty clay loam.

The transparency ranges from 2 to 4 m, which is 5 to 10 times the values observed in Gui-gui Creek; salinity is normal ranging from 31–32 ‰; and pH, though marking a somewhat high value of 8. 7, is uniformly distributed.

In order to obtain deeper knowledges about the characteristics of surface waters at Station 2 in Leganes and in Buyuan, an analytical study was carried out during the period from August 10 to 18 on BOD, bacterial count, quantity of plankton and desolved chloride insecticides contained in sea water sampled at the two places. The results of this study are shown in Table 8.

Table 8. Comparison of waters in Gui-gui Creek and Buyuan coast.
Data on BHC and DDT from Table 9.

Locality	BOD (5 days, 30°C)	Total bacterial counts/ml	Suspending matter (ml/l)	BHC α	BHC γ	BHC β	BHC δ	DDT pp'DDE
Leganes	7.40	5200	0.130	———	1.74×10^{-5}	1.98×10^{-5}	———	1.17×10^{-4}
Buyuan	7.12	180	0.025	———	9.22×10^{-6}	8.19×10^{-6}	———	7.68×10^{-5}

Setting aside the tracing of insecticides which will be described at length in the following section, BOD at the two stations was observed to be about 7 ppm. However, since the bacterial count registered a value of 5, 200/ml at Leganes against 180/ml observed on Buyuan coast creating a large gap of about 30 to 1 between the two places, it is estimated that BOD at the former station is largely attributable to bacteria and protozoa, whereas BOD at the latter station is caused by marine planktons.

The greater part of suspending matters are fine muddy particles at either. station. The volume of suspending matters at the former station was approximately five times as large as was observed at the latter.

Sea water sampled at the two stations contains, though in a very small percentage, desolved chlorine insecticides such as α - and β -BHC and pp'-DDE. the degree of pollution is about twice as heavy in Leganes as on Buyuan coast. pp'-DDT, op'-DDT, pp -DDD, PCP, and endrin were not detected.

In order to provide for the possible need of pumping up sea water for the hatchery operation, the content of chlorine insecticides adsorbed in the bottom deposit at Stations 1, 2 and 3 in Gui-gui Creek and Stations 1 to 12 on Buyuan coast was studied. As shown in Table 9, the bottom deposit of Gui-gui Creek is 2. 3 times and about 10 times as heavily polluted by α -BHC and β -BHC-like substances, pp'-DDE respectively as the deposit of Buyuan coast. Table 9 also indicates that BHC and DDT can be traced in the soil at the proposed pond site of SEAFDEC.

The team does not hold the view that the traced insecticides will directly produce an acute toxic effect on fishes and shrimps to be cultured, nor has it any intention to discuss the problem involved in insecticide application here. It is to be noted, however, that many of chlorine insecticides have a stabilized nature which not only allows them to be accumulated over a long period in the environment where they were applied, but also causes them to be condensed and deposited in aquatic animals living in such environment as they take them in orally through the food chain. Conversly, therefore, it is possible to measure, for the benefit of fish culturists operating in a certain district, the magnitude of the effect of inland waters in that district by using the insecticide content in soils, waters and animals in the district as an indicator. It may as well be mentioned here that insecticides condensed and deposited through food chain were detected, as shown in Table 8, in the body of Chanos chanos cultured in the vicinity of Leganes and shrimps (mostly Metapenaeus ensis) caught in the creeks flowing near the culture pond.

Sea water near Leganes site is liable to be affected by inland water and not stabilized in quality because the site faces the shore, and the Jalaud which flows from the hinterland area through paddy fields empties into the sea just near the site, also there are many fish farms around the site and on the coastline stretching northwards. The heavy turbidity caused by suspending muddy particles and large salinity fluctuation are the prominent characteristics of the sea water of Leganes, and this makes it justifiable to assume that desolved chlorine insecticides carried by inland water would be quite large in volume.

As described already, the facilities for training practical men on the bulk production techniques of shrimp larvae would be worthless unless the scope of the facilities is large enough to permit the full and practical application of such techniques. To meet this purpose, the pump should have a capacity of at least 2 tons/min. However, construction and maintenance of the filtering equipment having a capacity of 2 tons/min would entail many technical and financial problems because of the poor transparency of 50 cm and the heavy turbidity of sea water which is known to contain 0. 13 ml/L of suspending matters. Even if a sedimentation tank is constructed for forced filtration, its effect on chemical purification would be open to doubt. If, again, filtered sea water alone is to be used, then pure culture of diatoms would have to be carried out separately to supply them to larvae in the zoea and mysis stages, and this will make the breeding work so much more complicated and labour-taking.

For reasons described above, the team reached the conclusion that a hatchery should not be constructed at Leganes site. Further, based on a comprehensive judgement of the observation of water quality along the coast from Oton to San Joaquin which is represented by stations off Buyuan Balio, the impressions obtained by the frequent trips made to these stations, and the survey on matured shrimps described elsewhere in the report, the team feels convinced that it is possible to find a site suited for constructing a hatchery as a substation of the Leganes Station.

3 Agricultural Insecticides, BHC and DDC traced in water, soil and fishes

The station site in Leganes is on the periphery of the vast plain of Iloilo Province. Since paddy, corn and other crops are cultivated in this plain, consideration must be given to the penetration of agricultural insecticides applied in the plain for crop cultivation. Checking of this penetration is also necessary for the shore water of Buyuan which is proposed as the site of the shrimp hatchery. For this reason, materials collected at the two places were brought back to Japan and their content was analyzed by the chemists of Kagoshima Prefecture Fisheries Experiment Station. Results of the analysis are shown in Table 9, and the analytical process followed by the said chemists is described below for reference's sake.

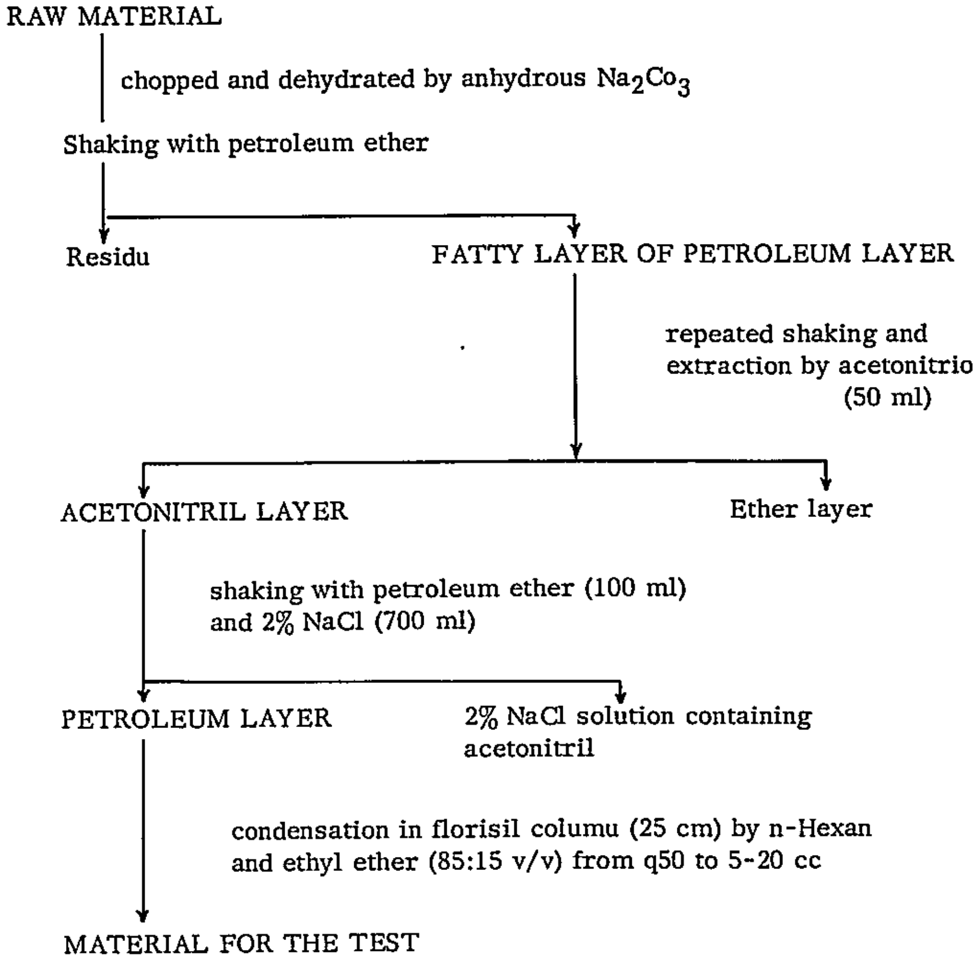
(1) Preparatory treatment of raw materials

The method and process set forth in The Shokuhin Eisei (Ed. by the Ministry of Welfare, Vol. 19, No. 10, p. 58, 1969) was adopted with some minor modifications.

Table 9. Analyses of agricultural chemicals traced in the sea water, bottom soil, shrimp and milkfish collected at Leganes and other localities in Panay Island. August 14-23, 1971. The contents are shown by ppm in wet materials; the bars indicate non-reaction to the analytical process; for β -BHC, similar reaction peaks are covered; for DDT, none of pp'DDT, op'DDT or pp'DDD was traced. Analyses were conducted at Kagoshima Prefecture Fisheries Experiment Station, Kagoshima City. For the process of analyses, see text.

Sample lot No. and sources of materials			BHC					DDT
			α –	γ –	γ –(like)	β –	δ –	pp'DDE
1	Sea water from Gui-gui Creek (St. 1, 2, 3), condensed from 4300 to 530 cc in 17 hours; August 22		—	1.74×10^{-5}	—	1.98×10^{-5}	—	1.17×10^{-4}
2	Sea water from Buyuan (St. 1-12); condensed from 4880 to 290 cc in 16 hours; August 18		—	9.22×10^{-6}	—	8.19×10^{-6}	—	7.68×10^{-5}
3	Body of a shrimp in the creek of Jamandre Fish Farm, Dumangas; August 20		6.44×10^{-3}	1.81×10^{-3}	—	8.65×10^{-3}	1.01×10^{-3}	9.46×10^{-2}
4	Plankton sample from Leganes shore water; precipitated from 20.1 to 2.6 cc; August 12		—	—	—	—	—	—
5	Pond bottom soil (Lot 3) of Jamandre Fish Farm, Dumangas; the pond treated recently by BRESTAN and GUSATHION; August 20		—	—	1.88×10^{-1}	—	—	5.22×10^{-2}
6	Bottom soil in Gui-gui Creek; August 23		6.41×10^{-4}	—	4.81×10^{-2}	—	—	1.66×10^{-1}
7	Sediments from shore at Buyuan (St. 1-12); August 14		2.69×10^{-4}	—	3.94×10^{-3}	—	—	1.52×10^{-2}
8	Pond bottom soil at SEAFDEC Station site (5 spots); August 23		—	—	1.16×10^{-1}	—	—	4.8×10^{-2}
9	Materials from Pond E, Jamandre Fish Farm, Dumangas, the pond treated long ago by BRESTAN and GUSATHION; August 20	Pond soil	—	—	1.20×10^{-1}	—	—	6.28×10^{-3}
		Milkfish meat	1.07×10^{-2}	2.55×10^{-2}	—	2.00×10^{-2}	5.0×10^{-2}	6.35×10^{-2}
		Milkfish viscera	5.80×10^{-2}	—	4.98×10^{-1}	—	5.2×10^{-2}	5.40×10^{-1}
10	The same material as above from Pond O, where no chemical treatment made in the past; August 20	Pond soil	—	—	9.48×10^{-2}	—	—	1.08×10^{-2}
		Milkfish meat	2.08×10^{-2}	5.8×10^{-2}	—	6.50×10^{-3}	3.43×10^{-2}	9.65×10^{-2}
		Milkfish viscera	1.12×10^{-1}	—	1.36×10^{-1}	—	2.60×10^{-2}	5.16×10^{-1}

Procrss of preliminary treatment of the material
for gas-liquid chromatophore test



(2) Analytical method

The test was made by means of agas-chromatographer (Electron capture detector, Type GC-3AE, Shimazu, Japan). The pure reference standard depended on BHC(α -, γ -, β - and δ -) and DDT (op'-DDT, pp'-DDT, pp'-DDE and pp'-DDD) standards, with deldrine as an internal standard sample.

(3) Results in general

In general fish and shrimp were detected to show the accumulation of BHC isomers (α -, γ -, β - and δ -) and DDT (pp'-DDE only). The sea waters in the Gui-gui Creek and at Buyuan coast showed the inclusion of BHC (γ - and β -) and DDT (11'-DDE). While, the bottom deposits were found to detect, in addition to α -BHC, allied γ -BHC with high peaks; also, pp'-DDE was traced as in waters and fishes.

The allied γ - BHC detected in the bottom deposits in Leganes is also found in the river bed materials in Kagoshima Prefecture, Japan, and it is presumed to identify with each other. The allied γ -BHC was so defined because of its equivalent retention time with γ -BHC under the reprenishment of QF-1. But, under the reprenishment of DC-11, its retention time does not harmonize with γ -BHC (Table 10). The problem requires further studies, and even its derivation from insecticide is not clear.

Table 10. Reaction time, referred to aldrine as standard, tested on BHC elements among the standard, the γ -BHC like element and the mixutre of the two under 3 reprenishments

Reprenishment		Standard	Material	Mixture
QF-1	1.5%	0.800	0.807	0.800
EGA	2%	1.803	1.877	1.817
DC-11	5%	0.468	1.091	0.468 (standard) 1.091 (material)

(4) Discussion

The sea waters in the Gui-gui Creek and Buyaan coast contain γ -BHC, β -BHC and pp'-DDE but in extremely low content, however, it is noted that its amount in the creek shows one unit higher than in Buyuan sea water.

Fishes

The shrimp, whether in BHC or DDT, carries higher amount than in milkfish, and their concentrations are 1000 to 10000 times higher than in sea water. The milkfish, derived from the two ponds (O and E, Table 9), show different concentration as below:

Pond E:	Total BHC	1.06×10^{-1} ppm:	pp'-DDE	6.35×10^{-2} ppm
Pond O:	" "	1.20×10^{-1} ppm:	"	9.65×10^{-2} ppm

Thus, it is presumed that Pond O had been polluted by chlorines somewhat higher than Pond E. In this connection some comments below may be added. The insecticide, BRESTAN, by which the Pond E had been treated, showed no peaks in the electron capture detector (concentration 1 ppm). The GUSATHION, also applied to Pond E, was not detected, but its chemical nature (organic phosphor) reminds the decomposition in pond water.

The detection in the viscera of milkfish of allied γ-BHC will suggest that they devour algal food incidentally together with bottom soil in pond, and the component remain in their digestive tract.

The insecticides BHC and DDT traced in the milkfish derived from fish ponds in Leganes, Panay Island are then compared to those found in a Japanese marine fish (Kurodai or Mylio macrocephalus) and shown in Table 11. It is apparent in the Table that the milkfish carry BHC more than the Kurodai, but DDT lesser whether in meat or

Table 11. BHC and DDT traced in milkfish (Chanos chanos collected in fish pond, Dumangas, Panay Island, Philippines) and kurodai (Mylio macrocephalus fished in shore water, Kushikino, Kagoshima Prefecture, Japan). Content expressed by (X 10^{-2}) except β BHC in milkfish meat 2 where by (X 10^{-3}); bars indicate non-reaction to analytical process. See also Table 9.

Species and body parts	BHC Total	α	γ	β	δ	DDT Total	pp'DDE	op'DDT	pp'DDD	pp'DDT
Milkfish:										
Meat 1	10.62	1.07	2.55	2.00	5.0	6.35	6.35	—	—	—
Meat 2	11.96	2.08	5.8	6.5	3.43	9.65	9.65	—	—	—
Viscera 3	11.00	5.8	—	—	5.2	54.0	54.0	—	—	—
Viscera 4	13.80	1.12	—	—	2.6	51.6	51.6	—	—	—
Kurodai:										
Meat	2.0	0.0	1.0	1.0	—	28.0	15.0	5.0	4.0	4.0
Viscera	9.0	2.0	3.0	4.0	—	157.0	67.0	33.0	36.0	21.0

or viscera. The higher content of BHC in the milkfish may be easily understood of its extensive use in the Legane region. And, the lower content of DDT (represented by pp'DDE) in the milkfish might lead to believe that the DDT had been used in the region long time before, knowing the DDT traced in the fish represented by a single isomar but not others.

Bottom deposits

As to the insecticides traced in bottom deposits or soils referring to the content of α -BHC and pp'DDE, that in the Gui-gui Creek show higher content than in the same from Buyuan coast. It seems natural that similar tendency is also reflected in the sea waters between the two regions compared.

4 Studies on shrimp biology

From the information of occurrence condition of natural post-larvae of Penaeus monodon which are caught in the south of Panay Island, it was believed that the spawning season of the said species lasts from May to August. In the present survey conducted in August, therefore, special attention was directed to the habit and sexual maturity of mature shrimps which are used for breeding. For this purpose, basket-nets and Sammai-ami[1/] were brought from Japan. The experimental fishing operation briefed below deals with the latter gear only, because the former failed to record any good catch.

Sammai-ami is a bottom net used chiefly for catching Kurumaebi[2/] in the southern part of Shiranui Sea extending off the western coast of Kyushu, Japan.

1/ Trammel net (gill-net) with 3 layers.
2/ Japanese shrimp (P. Japnicus)

The Sammai-ami is composed of three sheets of nets, the central net knitted with a fine thread of about 3 strands of 210 Denier and having a stretched mesh size of about 4 cm, and the two sheets of outer nets with a larger mesh size which are knitted with a thicker thread and sandwich the central net. One set of this net has a length of about 28 m and a height of about 1 m, and floats are connected to its upper edge and sinkers on the lower edge at regular intervals.

Experimental fishing was conducted during the period from August 9 to 13 in area just off the coast of Tigbauan with the cooperation of Mr. Goribay, a fishing operator, and his fishermen. The area of experimental fishing operation was within 500 m from the shore and had a depth of 3 to 10 m, and its bottom soil was composed of fine sand with some muddy material.

A variety of fishes and shrimps were caught by this fishing. All the shrimp individuals caught were classified by species and their total length, weight, sex and gonadal maturity were studied (See Table 12).

Table 12. Length and weight measurement of shrimps gill-netted in the shore water 3-10 m deep at Buyuan, Tigauan Municipality, Iloilo Province, Panay, Philippines. August 9 to 13, 1971. Total length measured from tip of rostrum to end of telson; maturity of ovary judged by visual examination.

Sex	Total length (cm)	Body weight (gr)	Ovarian weight (gr)	Remarks
Penaeus monodon (17 males and 5 females)				
Male	20.1	63		
"	20.2	65		
"	22.5	90		
"	21.1	73		
"	23.0	100		
"	22.1	85		
"	21.1	72		
"	20.0	60		
"	21.2	71		
"	21.0	68		
"	21.1	72		
"	18.5	49		
"	20.5	71.5		
"	21.0	74.6		
"	22.0	88		
"	21.7	79.9		
"	20.6	61.9		
Female	24.9	134.9	11.4	mature
"	24.0	110		mature
"	22.2	83		immature
"	26.3	145.3	6.3	immature
"	25.2	133.9	7.9	semi-mature
Penaeus merguiensis (21 females)				
Female	13.6	17.9		immature
"	14.6	19.6		mature
"	14.7	22.0		immature
"	13.8	17.2		mature
"	15.6	25.4		immature
"	15.5	25.9		mature
"	13.2	15.8		immature
"	13.8	18.4		mature
"	12.5	14.8		-----
"	14.2	20.1		immature
"	13.1	15.9		immature
"	14.5	22.6		mature
"	13.3	17.1		mature
"	15.4	25.2		mature
"	14.3	19.6		immature

"	14.7	23.3		-----
"	15.5	28.1		mature
"	13.5	16.8		immature
"	14.5	20.5		mature
"	14.1	17.8		immature
"	15.5	28.3		immature

<u>Penaeus</u> <u>japonicus</u> (3 males and 8 females)

Male	13.3	17.4		
"	15.5	21.0		
"	15.5	21.0		
Female	15.8	28.2	2.5	mature
"	16.5	34.3	3.2	mature
"	14.4	20.8	.1.4	mature
"	15.9	27.0		mature
"	16.8	33.8	1.6	mature
"	16.1	30.4	2.0	mature
"	15.7	27.6	0.8	immature
"	13.9	21.3	0.7	immature

<u>Penaeus</u> <u>semisulcatus</u> (11 males and 22 females)

Male	13.8	20.9	
"	13.2	17.1	
"	12.9	16.9	
"	12.3	14.9	
"	13.1	16.4	
"	14.0	20.0	
"	14.5	22.6	
"	13.5	18.7	
"	13.9	18.7	
"	13.1	16.3	
"	14.4	21.6	
Female	15.4	28.1	immature
"	14.6	26.6	immature
"	14.4	22.6	immature
"	14.9	24.9	mature
"	15.7	27.5	mature
"	17.2	37.6	mature
"	14.5	23.4	immature
"	17.3	42.9	spent
"	16.9	38.4	spent
"	14.6	26.2	immature
"	13.3	19.3	spent
"	17.1	40.0	spent
"	16.3	37.0	spent
"	16.9	38.5	spent
"	15.5	30.9	spent
"	16.9	37.6	immature
"	15.2	30.5	immature
"	16.7	38.2	spent
"	14.6	25.0	mature
"	16.4	34.5	spent
"	16.0	32.8	immature
"	14.2	24.3	immature

Penaeus indicus (5 males and 10 females)

Male	10.9	8.9	
"	11.9	11.4	
"	11.8	11.4	
"	12.7	9.7	
"	12.1	12.4	
Female	13.2	17.0	immature
"	12.8	14.7	immature
"	13.5	14.0	immature
"	14.6	23.1	mature
"	12.3	11.8	immature
"	11.9	14.4	immature
"	13.2	16.3	spent
"	13.7	17.7	spent
"	13.6	17.4	mature
"	13.6	17.7	spent

Metapenaeus ensis (one male and 31 females)

Male	10.9	7.9	
Female	10.0	6.5	immature
"	11.3	10.3	immature
"	11.8	11.2	immature
"	14.7	23.1	mature
"	14.6	23.1	immature
"	13.5	15.0	immature
"	17.5	36.3	mature
"	15.5	24.3	immature
"	14.4	19.5	immature
"	15.8	26.9	mature
"	14.8	23.0	mature
"	16.5	32.5	mature
"	15.2	22.5	immature
"	15.3	26.5	mature
"	14.8	22.3	mature
"	15.5	26.0	mature
"	16.4	32.5	mature
"	16.2	28.0	imm ture
"	15.7	27.8	immature
"	16.3	32.0	mature
"	15.6	26.0	immature
"	12.7	12.9	immature
"	12.9	12.2	immature
"	11.1	10.0	mature
"	14.4	23.8	immature
"	16.4	31.2	immature
"	15.4	27.3	immature
"	15.7	28.5	immature
"	15.8	27.6	immature
"	14.8	23.2	mature
"	12.1	13.5	immature

Findings of this study is briefed below.

(1) Many penaeid shrimps such as P. monodon, P. japonicus, P. merguiensis, P. indicus, P. semisulcatus and M. ensis which all important for the shrimp fisheries in the project area live along the said coast, and sexually matured individuals are also found in large quantities in August.

(2) Sammai-ami provides a good catch particularly when the coastal waters are turbides by the effect of winds, waves and heavy rains. Gravid female individuals of P. monodon caught by the said gear are active enough to be used as mature shrimps for breeding purpose.

(3) The weight composition of 134 shrimps in 6 species (Table 13) indicates that P. monodon grow biggest in size under natural condition in the region. Due to small number of materials handled it is hardly possible to estimate the growth of other species, which, though believed to attain never larger size than P. monodon.

(4) The experiment operation in 8 haulings does not present any information on

Table 13. Range of body weight in 6 species of shrimps gill-netted in the shore water of Buyuan on August 9 to 13, 1971. Fisgures show the number of individuals by species and weight.

Range of weight (gr)	P. monodon	P. merguiensis	P. japonicus	P. semisulcatus	P. indicus	M. ensis
10- 24		15	5	15	15	19
25- 39		6	6	16		13
40- 54	1					
55- 69	5					
70- 84	8					
85- 99	3					
100-114	2					
115-129						
130-144	2					
No.	22	21	11	33	15	32
Av. weight	87.3	19.7	25.6	25.5	17.5	23.0

the catch per unit of effort. But the relative abundance of the species may probably be reflected on the number of each species gill-netted.

(5) The fishes caught during the present operation were mostly bottom dwellers represented by rays, puffers, goatfishes, therapons, tripod fishes, slipmouthes, cobias, snappers, shark suckers, cutlassfishes and few others.

Commercial fishing in the region

The Panay Gulf, Visayan Sea and Sibuyan Sea present favourable trawling ground in the seas surrounding Philippine Ilands. The trawlers operating in these waters are 40 to 60 tons and equipped to work on the bottom 40 to 50 meter deep. The statistic shows the number of these trawlers amounting 229 ships among the total of the Philippines 481, and the mother ports of the 220 ships are Iloilo (40 ships) and Rohas (20) of Panay Island, and Bacolad (96), Cadiz (50) and Hinigaran (23) of Negros Island.

These trawlers engage in fishing usually 4 or 5 days for one cruise hauling 200-500 boxes (40-50 kg per box) in each cruise. The main catches include threadfin, bream, berycoid, squid, barracuda, lizard fish, Spanish mackerel, carangid, sillago, cutlass fish, butter fish, conger and few others. The penaeid shrimp is also included in the catch.

The purse-seine fishing is poorly developed in the region because of the fishing ground (for sardine, horse mackerel and scomber) in Palawan Sea is too far to reach, and of the lack of consuming large population.

The fishing in immediate shore waters finds angling, long line, small trawling, trolling and gill-net which are all operated by small boats locally known as "BANCRE" supported by outriggers in pair and equipped with or without engine. The fishing operation methods adopted by the fishermen, mostly introduced from abroad, are advanced, but the operation as enterprise is by no means highly evaluated. The inconvenient supply of fishing gear is said to be responsible for this.

For instance the small shrimp boats numbering some 80 centered at Ilog (Negros Island) harbour are equipped with the engine 9-10 horse power, and light dragging nets which lack even ground rope. The boats are permitted to work on shallow bottom down to 1.5 meter deep during low tide, and the catch of shrimp amounts the maximum of 17 to 18 kg in a cruise. Although the shrimp fishing ground in Ilog region is managed by governmental municipalities, the present scope of fishing operation appears hardly sufficient to exploit shrimp resources inthe sea.

The whole sale price of shrimp in the region is quoted 5-6 pesos per kg for tiger (P. japonicus), 9-10 pesos for flower (locally called bulik; species not known) 4-4.5 pesos for pink and banana (locally called suaje and putian respectively: species not known) and 9-10 pesos for black tiger (sungpo or P. monodon). In comparison, the fishes are quoted as follows; 1 peso for sardine, 1-1.5 pesos for lizard fish and 2.5-3 pesos for milkfish.

Summary

From those experiences and observation as described above the survey team arrived the basic concepts as noted below.

(1) The coastal area extending from Iloilo City to Miagao is inhabited by P. monodon and other important species of shrimps. Sexually matured shrimps were caught by Sammai-ami, and the use of small trawlnets is considered to attain even a higher catch. The matured shrimps are all sufficiently active and sexually matured to be used for hatching and breeding, provided that they are caught in large quantities.

(2) Neither the shrimp trawling nor the shrimp gill-netting is sufficiently developed in the project area because the fishing ground is limited by the bottom configuration. Interviews with local fishermen disclosed that the bottom undulations are rather too severe to allow for safe and efficient trawl-net fishing. At present, therefore, the shrimp fishery is not so well developed to allow fishermen supplying sufficient amounts of sexually matured shrimps by the designated time for stocking in the hatching tank.

(3) In order to expect substantial supply of mature shrimps, it will be necessary to encourage many fishermen to use Sammai-ami for shrimp fishing and to take a measure for purchasing mature shrimps at a special price during the hatching period.

(4) Shrimp trawling on the western side of Negros Island conducted mainly in the offing of Ilog is well developed by virture of abundant shrimp resources. Many fishing boats are operating in this area, and Bacolod City is the marketing centre of the shrimps caught. It would therefore be possible to purchase fresh, active and sexually mature shrimps from the fishermen or dealers in the said area. Quite naturally, speed boats equipped with a hold will be required for shipping the purchased shrimps to the hatchery alive and active, and it is considered that this transportation problem can be solved without much difficulty because of the short distance between Panay Island and Negros Island.

5 Basic plan for shrimp hatchery

(1) Location

A place on the coast from Tigbauan to St. Joaquin where the sea penetrates relatively deep into land, the turbidity caused by winds, waves and heavy rains are small, and the condition of currents is excellent.

(2) Area of hatchery site

About 1 ha, with a small road leading to the national highway.

(3) Availability of fresh water

A well or other source providing sufficient fresh water for drinking, laboratory and miscellaneous purposes should be available within the hatchery site. The present survey revealed that many wells supplying a sufficient amount of good fresh water are available in the belt of land extending from Tigbauan to St. Joaquin between the national highway and the coast line.

The water quality of a well in Buyuan Balio of Tigbauan, as disclosed by the present survey, is described below for reference.

> Temperature (30°C at surface, 28.6°C at bottom), salinity (0.0 at both surface and bottom), pH value (7.43 at surface) and total bacterial count 72/ml.

(4) Hatching and breeding tanks

At least ten hatching and breeding tanks will be required in order to complete the training of 20 trainees on the breeding techniques in a four-month period. Each tank should have a reinforced concrete construction and should preferably have a capacity of about 80 tons.

(5) Associated facilities

Main building: The main building should be so designed that its facilities suffice for accommodating about 25 staffs and trainees as well as for their rests, meals, small experiments and lectures during the daytime, and allow for the lodging of a total of eight persons. It should also be equipped with the equipment for communication with the Leganes Station.

Pump, Blower and Power House: Two units each of 3.5 kW pumps and blowers, one for constant operation and the other for stand-by, should be installed. A fresh water pump should also be constructed.

Sea Water Well and Fresh Water Well: A sea water well should be constructed at a point as close to the shore line as possible with a pipe line arranged approximately horizontally from the well bottom to the sea bottom so that sea water having a minimum depth of 1.5 m at time of low water level of spring tide may be allowed to flow in. Both the well tube and the piping should be given perfect water tight treatment. The inlet port of the piping in the sea should be fitted with a suitable strainer.

Warehouse and Garage: A warehouse for storing materials and equipment, serving also as a workshop, should be constructed together with a garage.

Garden: A garden should be properly arranged, and the roads should be all paved.

Jetty: A simple jetty for mooring boats is to be constructed.

IV. TALKS ON THE NATIONAL AND SEAFDEC PROJECTS

On August 27 and 30 the survey team joined by Mr. K. Matsushita, Embassy of Japan had informal meetings in Manila City with representative personnel from the Philippine Government, U. S. A. I. D., and the Amalgamated Project Management Service (Manila), Inc. On 27th Dr. K. Kuronuma took the chair in the meeting and on 30th Mr. A. Acosta, Philippine Fisheries Commission conducted the talking. The topics of the talks and discussions were focused mainly on the technical subjects including the design of the fish ponds and the construction of the buildings and other facilities associated on the station site. Thus, the speakers on the Philippine side were oftentimes represented by the personnel from College of Fisheries, University of Philippines including Messrs. R. O. Juliano, J. A. Carreon and M. M. Lijauco, and engineers, Messrs. C. L. Bayani, C. Lopez and A. Robricado of A. P. M. S. (Manila), Inc.

The discussions and exchange of views were made based mostly on the report of the first survey to Leganes submitted by the present survey team, and also several sheets of blue-prints on the design of fish pond layout and survey map of the site, which had been prepared by the Philippine workers for the occasion and other purposes.

A number of technical problems on the designing and layout of the ponds which are partly shared by the two projects were discussed and agreed upon between the two parties. But, some of the subjects bearing high significance to both sides were left without solution or compromise. They may be itemized as follows.

(1) The level of the bench mark (BM 1) calculated by the survey team 332 cm above D. L. was not accepted by the Philippine workers. And, the latter expressed a view to prepare a writing to give their reasoning of the disagreement as well as their comments towards the report of the survey team as a whole.

(2) As to the layout of the main canal system the Philippine side insisted to adopt their original plan (Fig. 13 in the previous report of the survey team) and declined to accept the plan proposed by the survey team (Fig. 25, the same report). The Philippine workers also insisted to establish a gate at Gui-gui Creek side in the main canal, but the survey team as proposed previously insisted to take the creek water freely into the canal without gate. The issue remained unsolved, and the two parties agreed to continue further investigation on the subject.

(3) The Philippine side made inquiry on the amount of freshwater from two sources, deep well and river, required in the SEAFDEC working programme, but the survey team was not ready to present satisfactory answer to the question.

(4) The Philippine workers requested the survey team to elaborate the plans of both pond and building which were proposed and recorded on the report so as to estimate the costs required. The survey team agreed to supply the materials on documents.

Despite of some problems and subjects remained unsolved during the time of meetings the two parties exchanged each other their gratitudes for the works, and promised full cooperation as before towards the completion of the two projects.

VI. FUTURE PLAN

Following the recommendation of the Council Meeting held at Manila City in January 1971, the plan of the Aquaculture Department, SEAFDEC including physical set-up, the operation and the budget should be presented for approval to the coming Council Meeting at Bangkok scheduled in June 1972. Under such circumstances the planning will have to be finalized by that time, or, if not, materialized as far advanced as possible.

The survey team, referring to technical problems to be implemented in immediate future, believes the necessity to accumulate further knowledges on the biology (taxonomy, ecology, etc.) and fishing (method, season, ground, catch, etc.) of the shrimp in the region. The knowledge and information on these subjects which have been assembled on the fields and on literatures are hardly adequate or sufficient in order to conduct researches and training programmed at the Station in Leganes. It is anticipated that the implementation of the works to obtain true facts on shrimp biology and fishing as defined above will require at least one year period and 4 or 5 scientists specialized in biology, hydrology, aquaculture and fishing technology.

The survey team also recommends to facilitate some scholarships for the training of shrimp culture practices currently conducted in Japan. Those students trained in such a way for the period of 4 to 6 months will be well suited and required to the posts of the counter-part workers appointed to the SEAFDEC AQUACULTURE STATION at Leganes.

APPENDIX

A Guide to Designing of Coastal Aquaculture Pond in Tropical Regions

by

Makoto Nakamura

Development of coastal culture of milkfish and other species like shrimps and mullets has a long history in the tropical regions of Southeast Asia, with many culture ponds covering a wide area at present. Since sea water is usually used for this pond culture, its supply and discharge is of paramount significance for successful fish culture operation. In other words, maximum utilization of the tidal range accomplished in the design of the pond works major factor for the increased production of fishes in the pond. Though the culture ponds found in area are designed on the basis of the techniques devised and improved through many years of past experience, the writer considers that there still remain much room for improvement if their design is reviewed from the viewpoint of effective utilization of tidal range.

Higher productivity of fishes from a pond calls not only for better pond design but also for consideration of many technical aspects such as stocking rate, fertilization, stock manupulation, ecological stability, prey-predator relation, feeding, harvesting and so on.

This section gives a brief account of the tidal range and its relationship with the pond construction which the writer hopes will serve as a guide to the future design of culture ponds in the project area. The writer will feel more than pleased if the explanation given below proves instrumental in the actual design of ponds.

1 Tidal condition

Water supply and discharge in coastal aquaculture is usually conducted by making use of the tidal level difference. Hence, the tide level and the pond water level are the most fundamental factors to be considered in the design of the pond. The tidal characteristics are generally indicated by the following notations.

H. A. T.	(High astronomical tide)
M. H. H. W.	(Mean higher high water)
M. L. H. W.	(Mean lower high water)
M. S. L.	(Mean sea level)
M. H. L. W.	(Mean higher low water)
M. L. L. W.	(Mean lower low water) = D. L. (Datum level)
L. A. T.	(Low astonomical tide)

To obtain the values of the above tidal characteristics, tide level observation should be carried out theoretically for a period of more than a year. When the tidal constant is obtained by subjecting the values of such a continuous observation to harmonic analysis of tide, then the long-range values can be forecast by the synthesis method. Tide level values are recorded at major ports of the world and shown in the Tide Table which is published each year and provides the basis for tide level forecasting.

To estimate the tide level values on the coast where culture pond is planned to be constructed, it is expedient to resort to the ratio of tidal range and the time difference of tide from which the tide level relationship between the site in view and l the standard port can be obtained.

1.1 Ratio of tidal range and time difference of tide

The ratio of tidal range, which can be expressed by the following equation, is the rate of tidal difference of spring tide at the standard port (a port whose forecast tide level values are shown in the Tide Table) to that along the coast where the pond is to be created.

Ratio of tidal range = Tidal difference of spring time along the coast for culture pond construction/Tidal difference of spring time at the standard pond . (1)

In areas where sea water records a large diurnal ine‚ .ality (daily difference betwttn two high-tide levels and two low-tide levels), however, the ratio of mean tidal difference is adopted.

The time difference of tide is used added to the time of the high and low tide at the standard port; it is obtained from the following.euation.

$$\text{Time difference of tide} = (\text{M.H.W.I.})_F - (\text{M.H.W.I.})_S - 30/31\,(\lambda_F - \lambda_s) + (S_F - S_s) \quad \ldots\ldots \quad (2)$$

where, M.H.W.I. : Mean high water interval
λ : East longitude expressed in unit of time
S : Standard time
F, s : Denotes values on the coast in view and values at the standard port, respectively.

The following simple method can be applied to obtain the ratio of tidal range.

The high and low tide levels on the coast in view are obtained by actual ovservation according to a datum level temporarily established (See Fig. 10Aa), and the level and time of high and low tide at the standard port on the same day are obtained by calculation and the tide level curves are prepared for both high and low tides (See Fig. 10Ab).

To obtain the ratio of tidal range, the differences between the observed and calculated tide levels, i.e., ζ_{O1}/ζ_{C1} and ζ_{O2}/ζ_{C2}, are to be calculated. The mean of these values is the ratio of tidal range. In other words,

$$\text{Ratio of tidal range} = R\zeta = 1/2(\zeta_{O1}/\zeta_{C1} + \zeta_{O2}/\zeta_{C2}) \quad \ldots\ldots \quad (3)$$

However, if the diurnal inequality is large during the period of spring tide, the ratio is to be obtained by a number of observations, and the mean of the observed values is employed.

The time difference of high and low tide can be obtained from the following equations.

$$\left.\begin{array}{l}\text{Time difference of high tide} = \Delta t_H = t_{O2} - t_{C2} \\ \text{Time difference of low tide} = \Delta t_L = [(t_{O1} - t_{C1}) + (t_{O3} - t_{C3})]/2\end{array}\right\} \quad (4)$$

1.2 Standard tidal level

In all the countries of the world, the base level is established to indicate the ground elevation or sea bottom depth. It is therefore desirable that the tidal level be indicated refer to such a base level. However, the tidal level may be indicated on the basis of a base level established especially for the region concerned. Such a base level can be obtained in the following procedure.

From the calculated values at the standard port shown in Fig. 10Ab, the high and low tide levels from M.S.L. are to be obtained and called h_{C1} and h_{C2} respectively. Then, from the observed values shown in Fig. 10Aa, the high and low tide levels in the pond area can be obtained by the application of the following equation.

$$\left.\begin{array}{l} h_{O1} = h_{C1} \cdot R\zeta \\ h_{O2} = h_{C2} \cdot R\zeta \end{array}\right\} \quad (5)$$

The boundary line of h_{O1} and h_{O2} is M.S.L. at the site in view. When the area's own M.S.L. is obtained, values of tidal characteristics in that area can be calculated from the following equations wherein o stands for the values at the site in view and s for the values at the standard port.

$$\begin{array}{l}
(H.A.T.)_o = [(H.A.T.)_s - (M.S.A.)_s]R\zeta + (M.S.O.)_o \\
(M.H.H.W.)_o = [(M.H.H.W.)_s - (M.S.L.)_s]R\zeta + (M.S.L.)_o \\
(M.L.H.W.)_o = [(M.L.H.W.)_s - (M.S.L.)_s]R\zeta + (M.S.L.)_o \\
(M.H.L.W.)_o = [(J.H.L.W.)_s - (M.S.L.)_s]R\zeta + (M.S.L.)_o \\
(M.L.L.W.)_o = [(M.L.L.W.)_s - (M.S.L.)_s]R\zeta + (M.S.L.)_o \\
(L.A.T.)_o = [(L.A.T.)_s - (M.S.L.)_s]R\zeta + (M.S.L.)_o
\end{array}$$

The tidal level is usually indicated with M.L.L.W. taken as zero. If $(M.L.L.W.)_o$ is assumed to be zero and taken as the standard tidal level in the area in view, then the following equations can be established.

$$\begin{array}{l}
(H.A.T.)_F = (H.A.T.)_o - (M.L.L.W.)_o \\
(M.H.H.W.)_F = (M.H.H.W.)_o - (M.L.L.W)_o \\
(M.L.L.W.)_F = (M.L.L.W.)_o - (M.L.L.W.)_o = 0 \\
(L.A.T.)_F = (L.A.T.)_o - (M.L.L.W.)_o
\end{array}$$

where, $(\quad)_F$ is intended to indicate the tidal levels in the pond area with M.L.L.W. taken as zero.

The above observations and calculations suffice for the planning of water supply and discha4ge of a culture pond. However, levelling work will be required to find the relationship with the standard tidal level at the standard port or other places. It may as well be added here that the M. S. L. difference between the standard port and the secondary port is shown in the International Tide Table.

Seasonal changes in the mean tidal level can be obtained only by a long period of observation. If these changes are required within a limited time, then the values at the standard port may be used.

2 Hydrology of culture pond

2. 1 Level of bottom in pond

The bottom level of the pond is required to vary by the species of fishes cultured. The writer wishes to emphasize here that the level should by all means be large enough to make the pond completely empty, and for this purpose, it should be approximately equivalent to M. H. L. W.

2. 2 Size of water gate

In utilizing the tidal level difference for water supply to and discharge from the pond, the water gate is designed according to the size of the pond concerned.

2. 2. 1 Water supply and discharge without gate manipulation

The change in water level of a pond can be obtained from Fig. 27 shown in the first survey report using the water cross section at the gate [(A) m^2], area of the pond [(Sp) m^2], tidal range in front of the intake [(ζ_o) m], and tidal frequency [(T) sec].

Meanings of the notation given in the said figure are as follows.

C is the coefficient of discharge, which can generally be considered to range from 0. 7 to 0. 8.

S can be obtained by the following equation.

$$S = Sp\,(1 - \pi\, t_L/T) \qquad \text{(8)}$$

where, $\pi = 3.14$, $t_L = L/\sqrt{gh}$ [$L^{(m)}$ is the distance from the intake to the farthermost point of the pond, and $h^{(m)}$ is the depth of water of the pond), and g = gravitational acceleration or 9. 8(m/sec^2)].

The volume of water flowing in or out by each flux and reflux (Q), mean flow velocity (V), and maximum flow velocity (Vmax) can be expressed by the following equations.

$$\left.\begin{array}{l} Q = S\,\zeta \\ \overline{V} = 2Q/AT \\ Vmax = \overline{V}/0.76 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

A process of the above calculation may be explained by way of an example below.

The following calculation is intended to obtain the change (ζ) in water level of a pond and the volume of water flowing in and out at each flux and reflux (Q) asseming that the pond has an area of 5 ha (= 200 m x 250 m) and an intake with the water cross section 3 m^2, and further assuming that the tidal range (ζ_o) in front of the intake is 1.5, tidal period 12 hrs, average pond depth is 0.8 m, and intake is installed at one end of pond side of 200 m long.

The given conditions can be arranged as follows.

$Sp = 50,000\ m^2$, $A = 3\ m^2$, $\zeta\ o = 1.5$ m, T = 12 hrs = 43,200 sec,

h = 0.8 m, and $L = \sqrt{200^2 + 250^2} = 320$ m

Using these data, the following calculation can be worked out.

Applying equation (8),

$$t_L = 320/\sqrt{9.8 \times 0.8} = 114 \text{ sec}$$

Applying equation (9),

$$S = 50,000\,(1 - 3.14 \times 114/43,200) = 49,600\ m^2$$

$$S/AC = 49,600/3 \times 0.7 - 2.36 \times 10^4$$

$$\zeta o/gT^2 = 1.5/9.8 \times 43,200^2 = 8.2 \times 10^{-10}$$

Using Fig. 27,

$$\zeta/\zeta_o = 0.50$$

$$\text{i.e.,}\ \zeta = 0.50 \times 1.5 = 0.75 \text{ m}$$

Applying equation (9) again,

$$Q = 49,600 \times 0.75 = 37,200\ m^3$$
$$\overline{V} = 2 \times 37,200/3 \times 43,200 = 0.574 \text{ m/sec}$$
$$Vmax = 0.574/0.76 = 0.7552 \text{ m/sec}$$

The above calculation produces the following results.

The average flow velocity is 0.57 m/sec, and 37.200 m^2 of water flow in and out at each flux and reflux whereby the water level of the pond changes within a range from 0.4 m to 1.2 m.

2.2.2 Water supply and discharge by gate manipulation

Assuming that n-times of flux are required to fill sea water to the specified level (H), the necessary gate area (A) can be obtained by the following process.

1) The tide curve (h_o) in front of the gate is prepared.

2) The change in the water level of the pond is obtained by the method described in 2.2.1 assuming A at an appropriate value A_1. Then, the water level curve of the pond (h) is obtained by reducing the h_o curve to a scale of ζ / ζ_o. At this time, an identical phase is adopted for the two curves, h and ho.

3) When the gate is fully opened, water can be filled to level shown in Fig. 10 B by one rising tide. The gate is then closed, and opened again for the second water supply when the outside sea water level becomes higher than the pond water level. Since the water level of the pond shows a change which is parallel to the h curve, water can be filled to level b. By the repetition of this process, the level to which water can be filled by n-times of rising tide can be obtained.

4) Processes 2) and 3) are repeated with the gate area (a) assumed at a suitable value.

5) From the findings of processes 2), 3) and 4), Fig. 10 C is prepared, and the gate area (A) required to fill sea water to level H by n-times of rising tide can be obtained from this figure.

6) The method described above can also be applied for the discharge of pond water. The water level of the pond reduced by water discharge at each rising tide is a', b', c', d' ..... shown in Fig. 10 B.

2.3 Main gate and sub-gate

If a main gate is installed on the main canal from which water is supplied to a number of ponds, the fluctuation of outside sea water level (ζ_o) transforms itself into the fluctuation of water level inside the main gate (ζ_i) which is reflected on the passage of water to the pond through the sub-gate. The size of such main gate is determined by the following process.

Assuming, as a fundamental condition, that the sub-gate will be so designed that the water level fluctuation in the pond becomes ζ_p, the following equations can be established.

$$\left.\begin{array}{ll} \text{Rate of passage from canal to pond} & R_p = \zeta p / \zeta i \\ \text{Rate of passage from sea to canal} & R_i = \zeta i / \zeta o \\ \text{Rate of combined passage} & R = R_p \; R_i = \zeta p / o \end{array}\right\} \quad \ldots\ldots \quad (9)$$

The value of ζ p can be obtained from the sea water exchange condition of the pond, and that of ζ o is already given as one of the sea water conditions, so that R can be readily obtained.

If the sub-gate is made large in size, the main gate size may be reduced because the value of R_p increases. If R_p is set at an assumptive value, the sub-gate size can be obtained for each pond by the method described in 2. 2. At this time, the rate of passage of the main gate (R_i) should be expressed by the following equation.

$$R_i = R/R_p$$

The method explained in 2. 2 should also be employed to obtain the value of R_i, and the effective pond area in this case can be obtained from the following equations.

$$\left. \begin{array}{l} S_t = S_1 + S_2 + \ldots\ldots\ldots S_n \\ S = S_t R \end{array} \right\} \quad \ldots\ldots\ldots\ldots\ldots \quad (10)$$

where, S_1, S_2 . . . . the effective area of each pond (value obtained from equation (8)].

The above-mentioned method is to be applied by assuming various values for R_p so as to obtain the size of the main gate and sub-gate which are most economical considering the gate design and rate of passage.

Fig. 1. Range and fluctuation of water level and salinity measured in the Gui-gui Creek in front of the BM 2 from 0700 to 2100 hours, August 11, 1971. Calculated curve of tidal change at Leganes coast compared. Data from Table 1. Curve of water level drawn from the calculation explained in the report of the first survey.

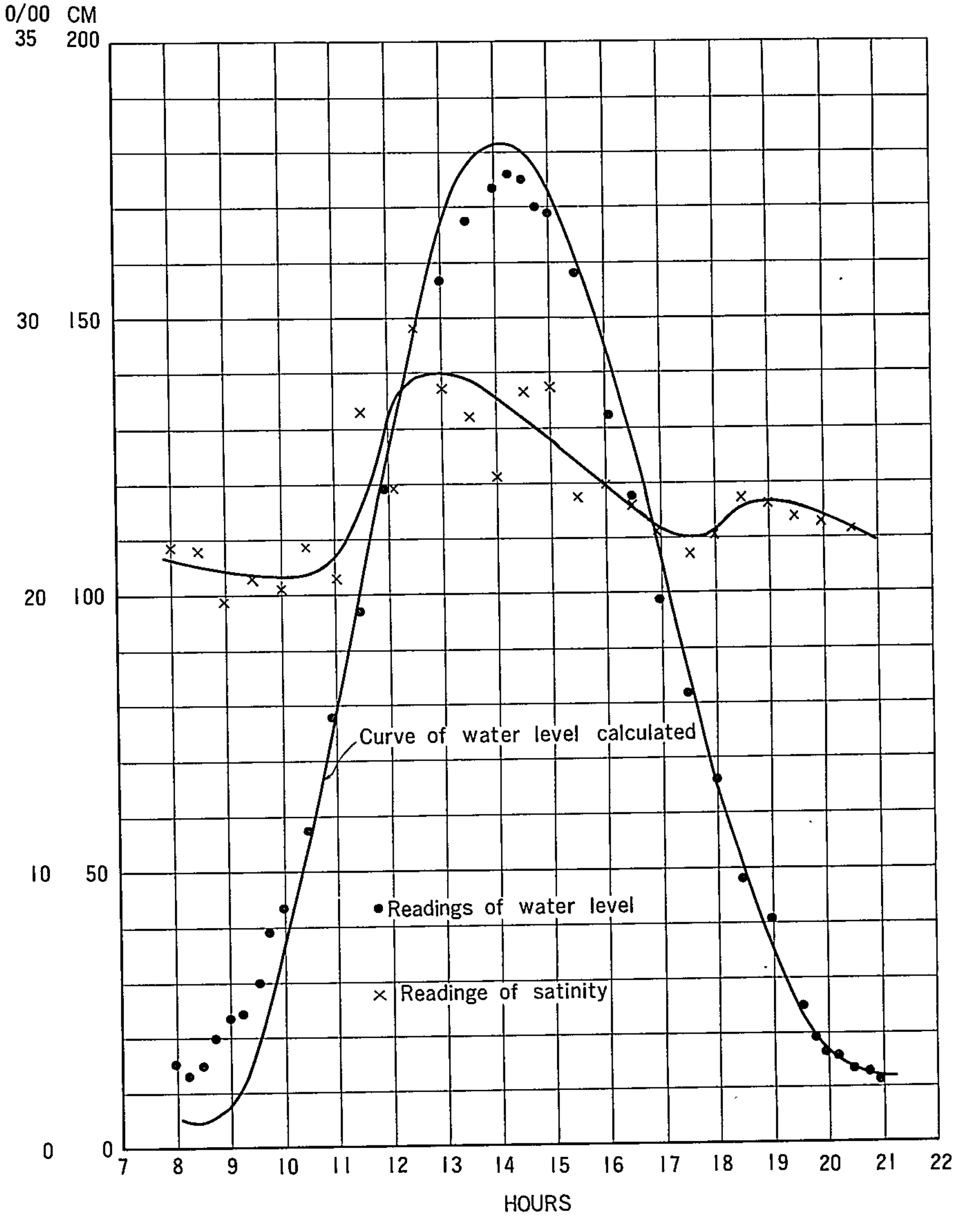


Fig. 2. Continuous 14-hour measurement of water level and salinity in the Jalaud River in front of the BM 1 from 0800 to 2100 hours, August 11, 1971. Data from Table 1.

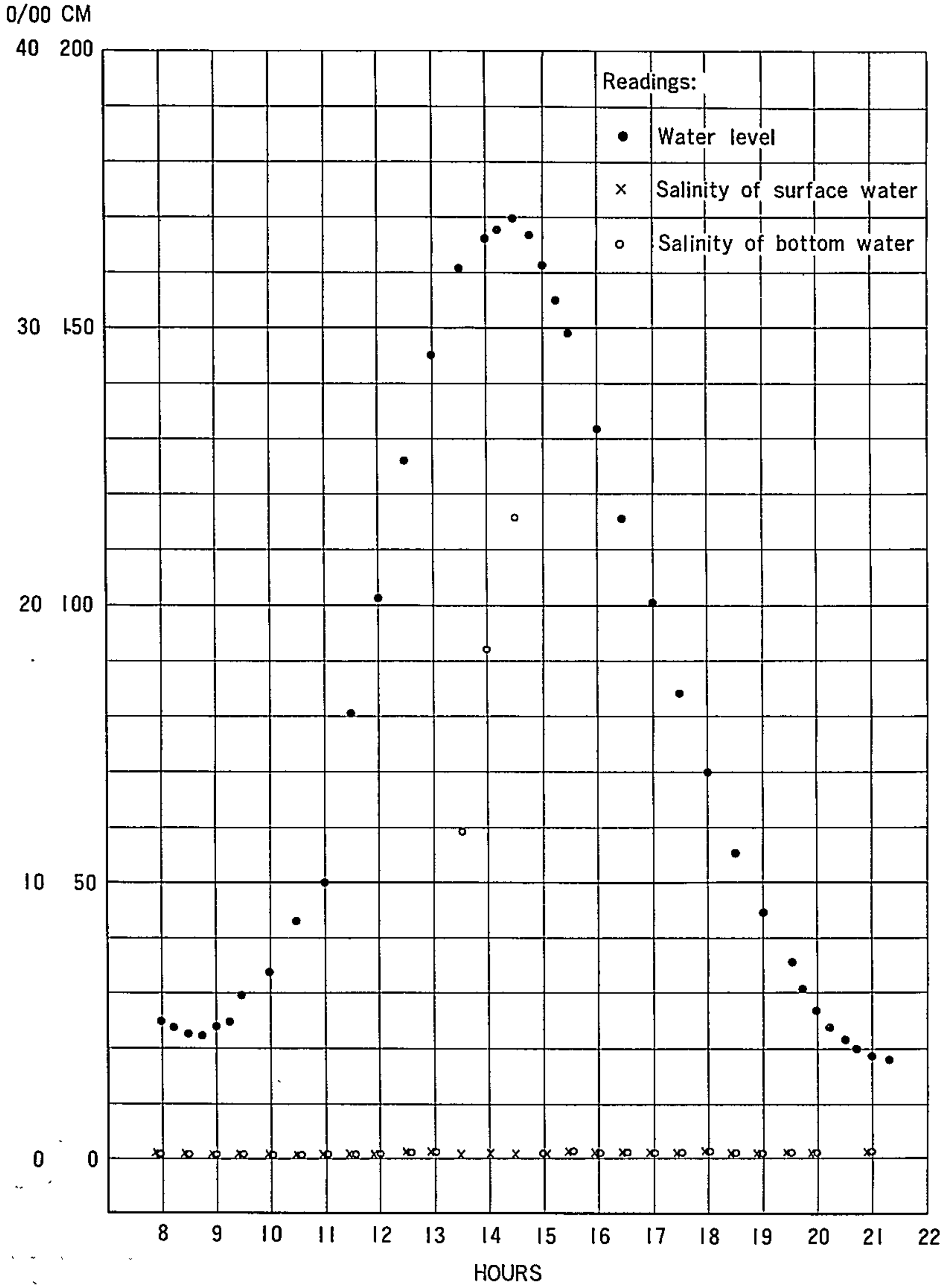


Fig. 3. Continuous 14-hour measurement of water level and salinity in the Jalaud River in front of the BM 1 from 0700 to 2030 hours conducted on August 23, 1971. Data from Table 2.

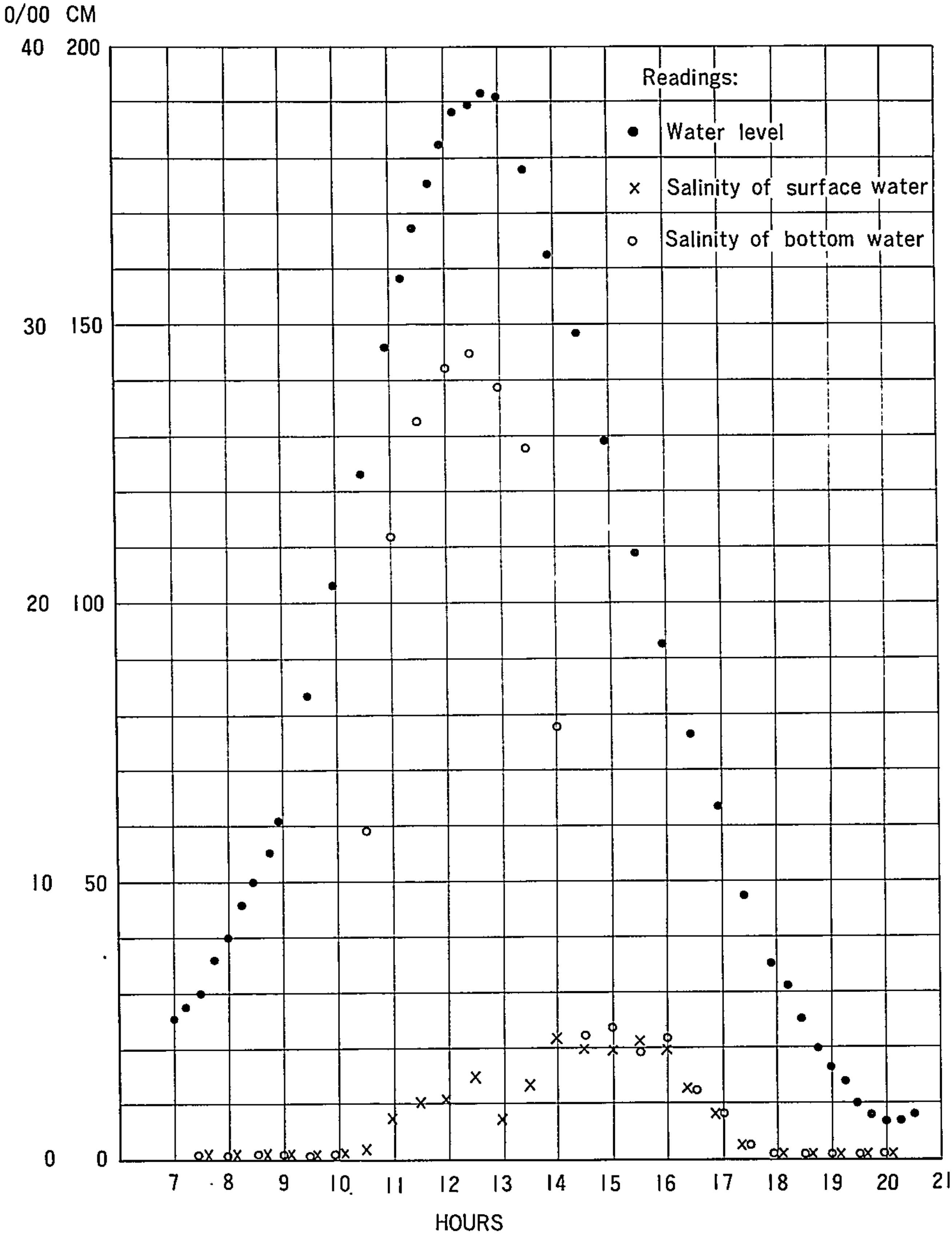


Fig. 4. (top) Cross-section at the station about 700 m above the BM 1 in the Jalaud River, where the flow measured : (bottom) Continuous 14-hour 14-hour measurement of the velocity of water flow and calculated amount of discharge at the station. August 23, 1971. Data from Table 3.

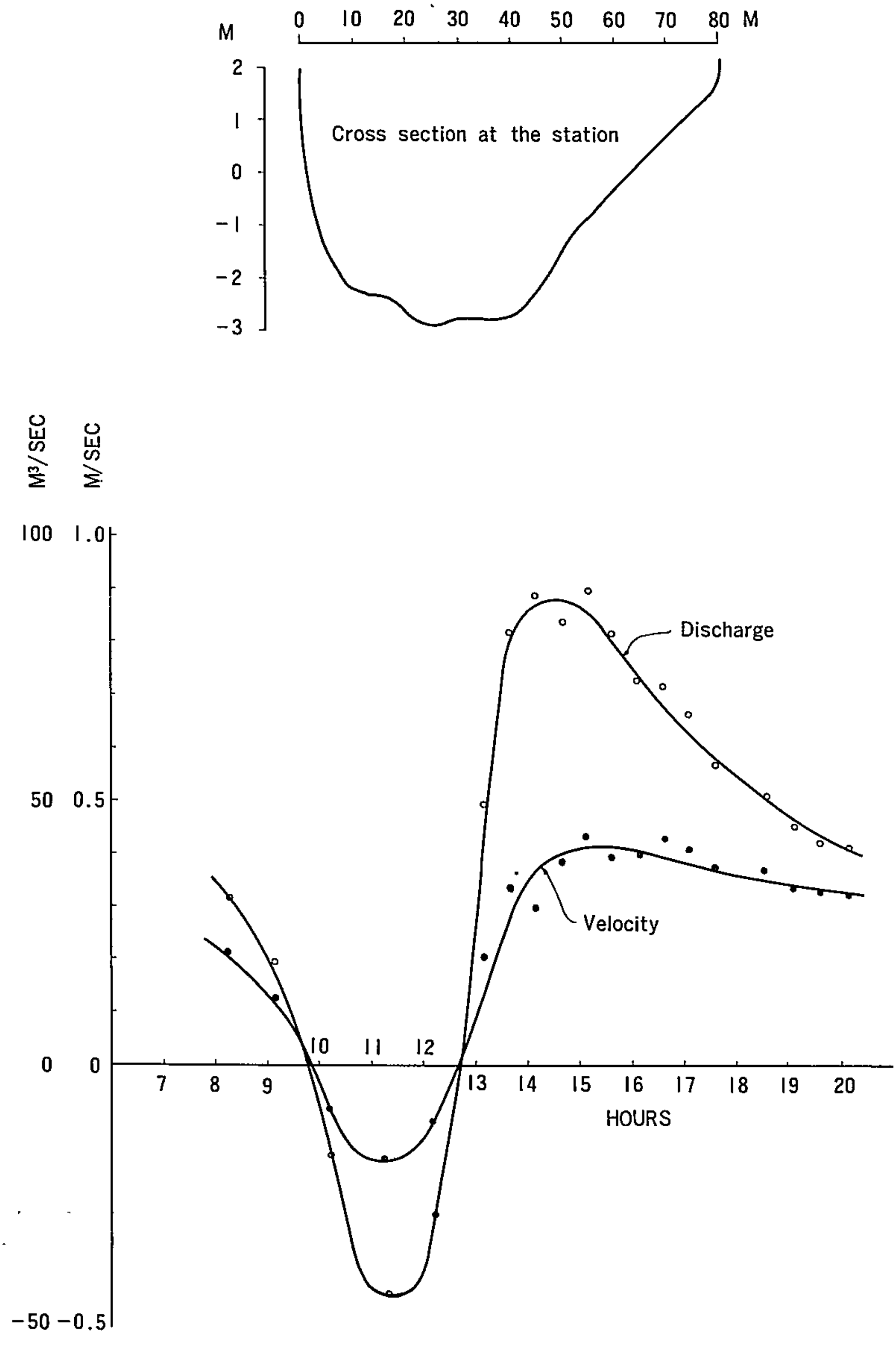


Fig. 5. Map to show the survey line at Buyuan, Tigbauan Municipality facing the Panay Gulf with bottom contour lines of 3, 6, 10, 30, 50, and 100 meters. The map abridged from The Board of Technical Surveys and Maps (Sheets 3452 II and 3451 I), Manila. See Fig. 8 for the details of the survey & stations.

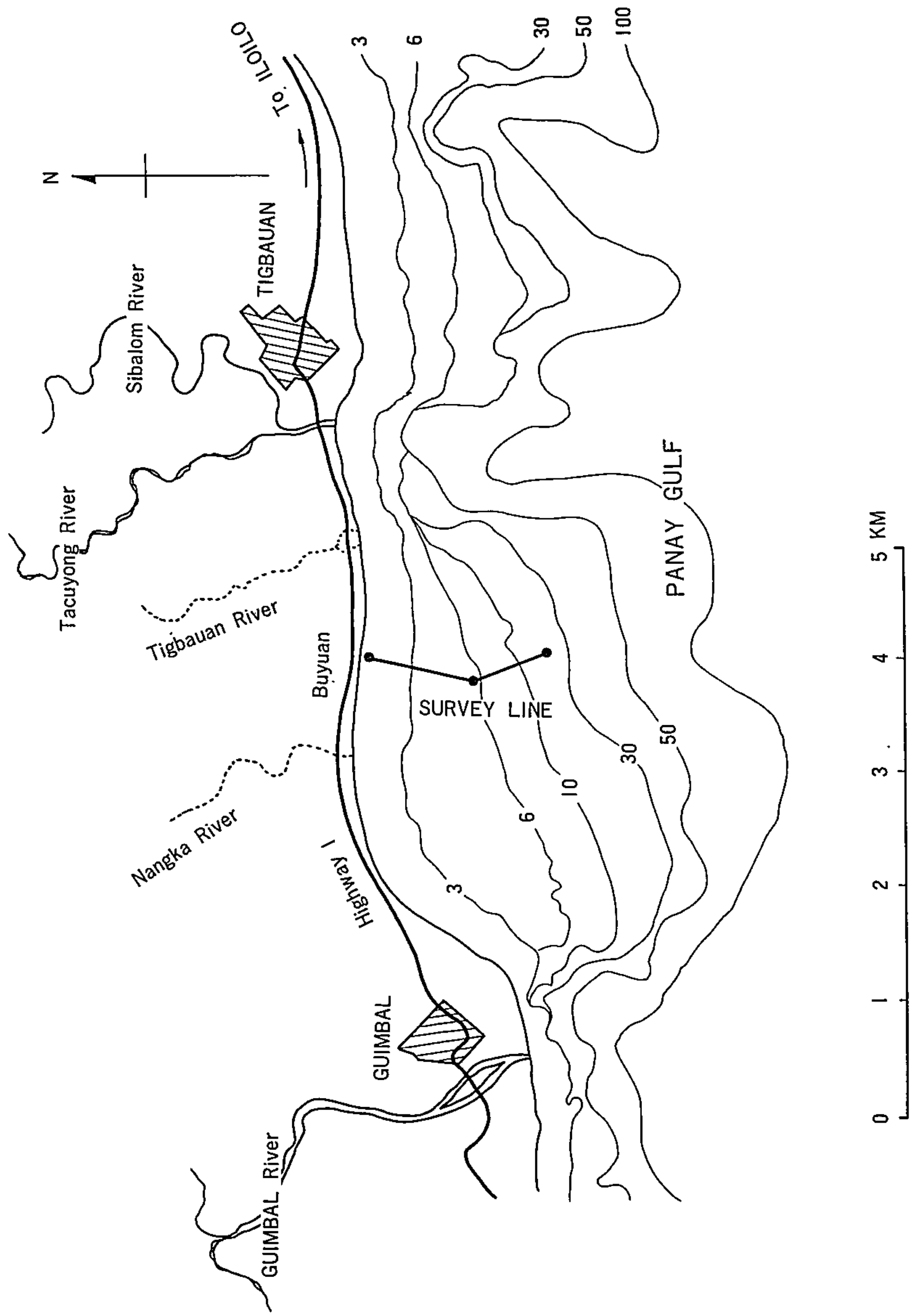


Fig. 6. Hydrological survey at the 12 stations in the Gui-gui Creek and shore water off the creek conducted from 1600 to 1830 hours (falling tide) on August 10, 1971. Readings given for surface and in parenthesis bottom waters. Data from Table 4.

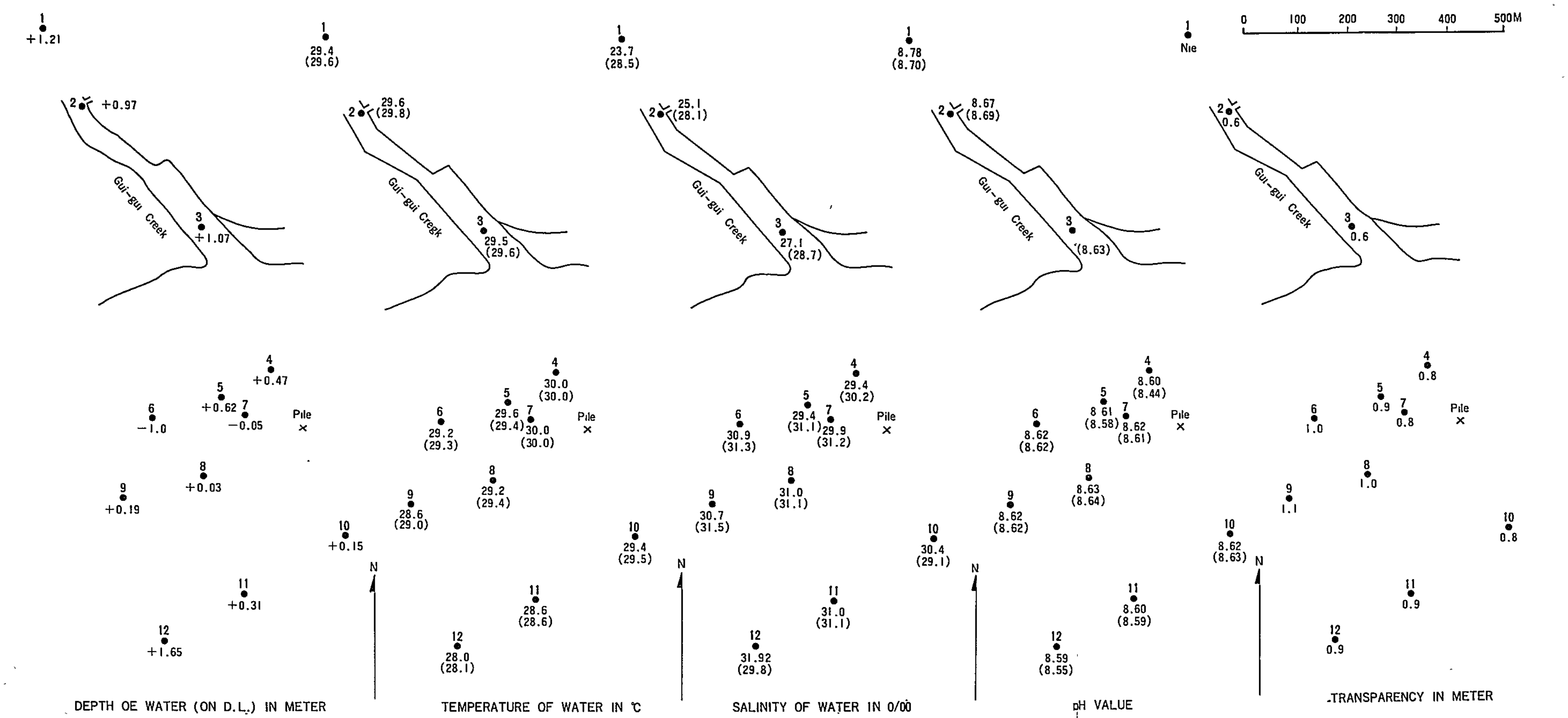


Fig. 7. Hydrological survey at the 12 stations in the Gui-gui Creek and shore water off the creek conducted from 0922 to 1112 hours (rising tide) on August 12, 1971. Readings given for surface and in parenthesis bottom waters. Data from Table 5.

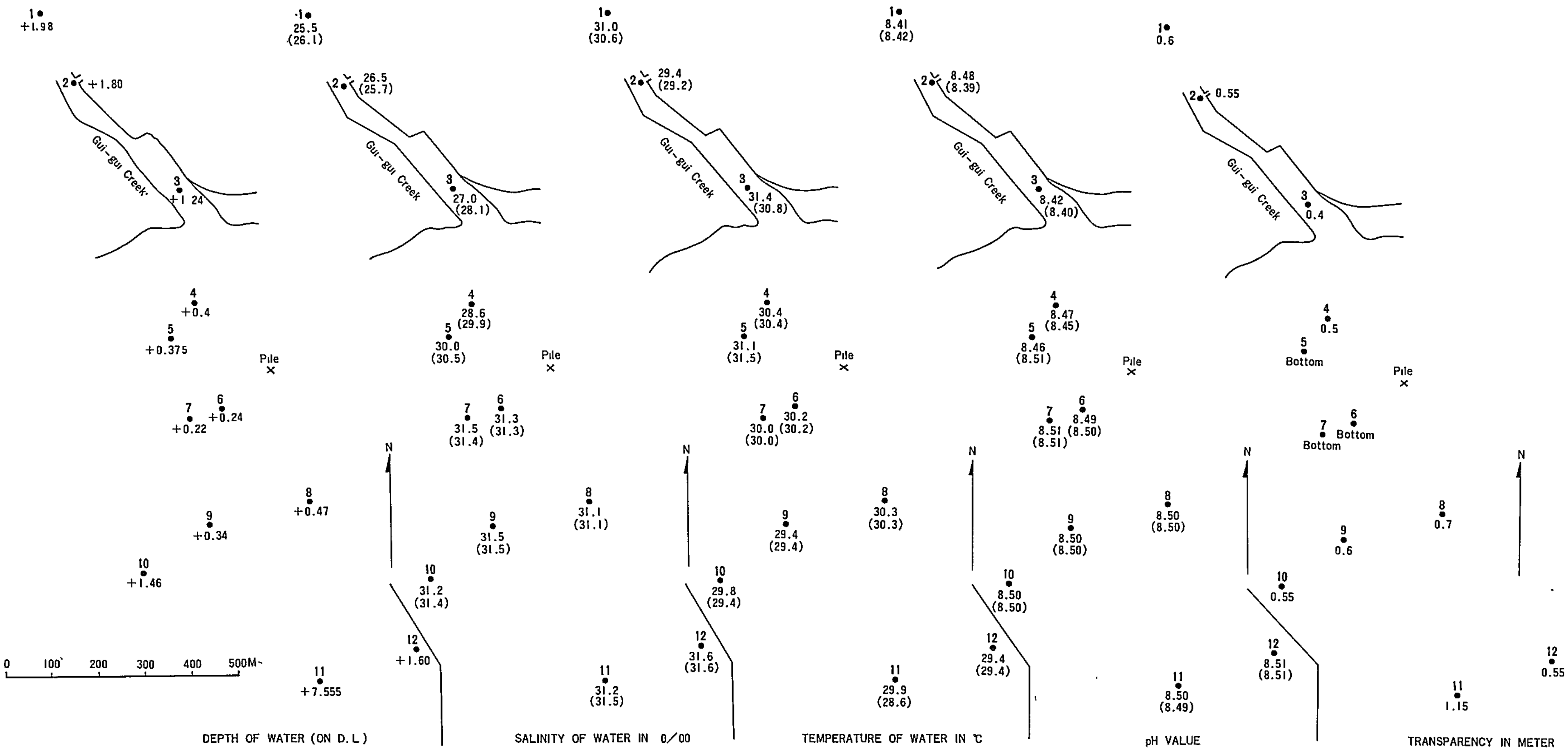


Fig. 8. Hydrological survey at the 13 stations in shore water off Buyuan, Tigbauan Municipality conducted on August 14,1971. See Fig. 5 for the position of the survey line on map. Data from Table 6. Readings given for surface and in parenthesis bottom waters.

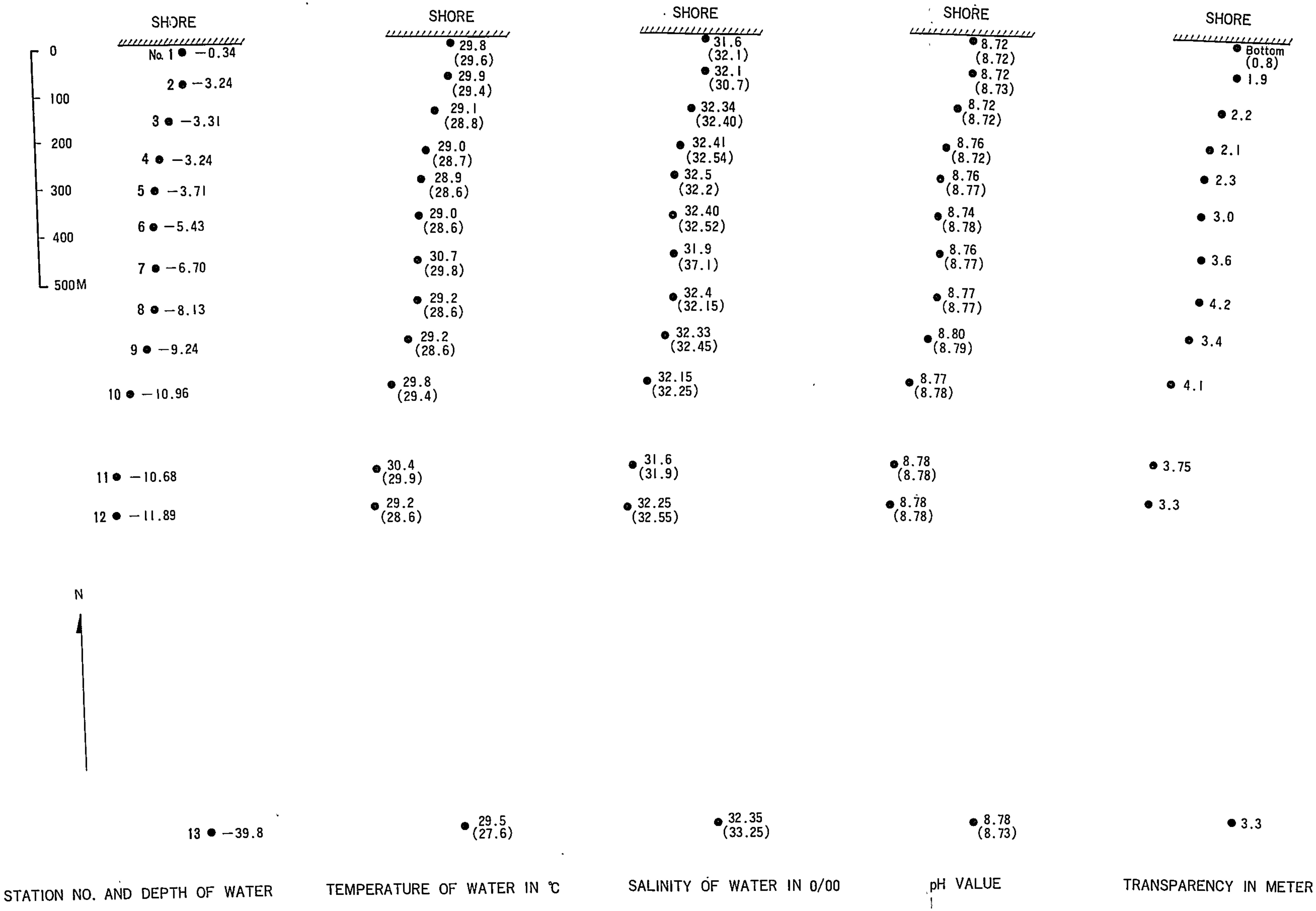


Fig. 9. Gradation analysis curves by grain size of the bottom deposits or sediments at the 2 stations in Gui-gui Creek and 4 stations in Buyuan coast with a scale defining the grains. For the position of each station, see Figs. 6 and 7. Also see Table 7.

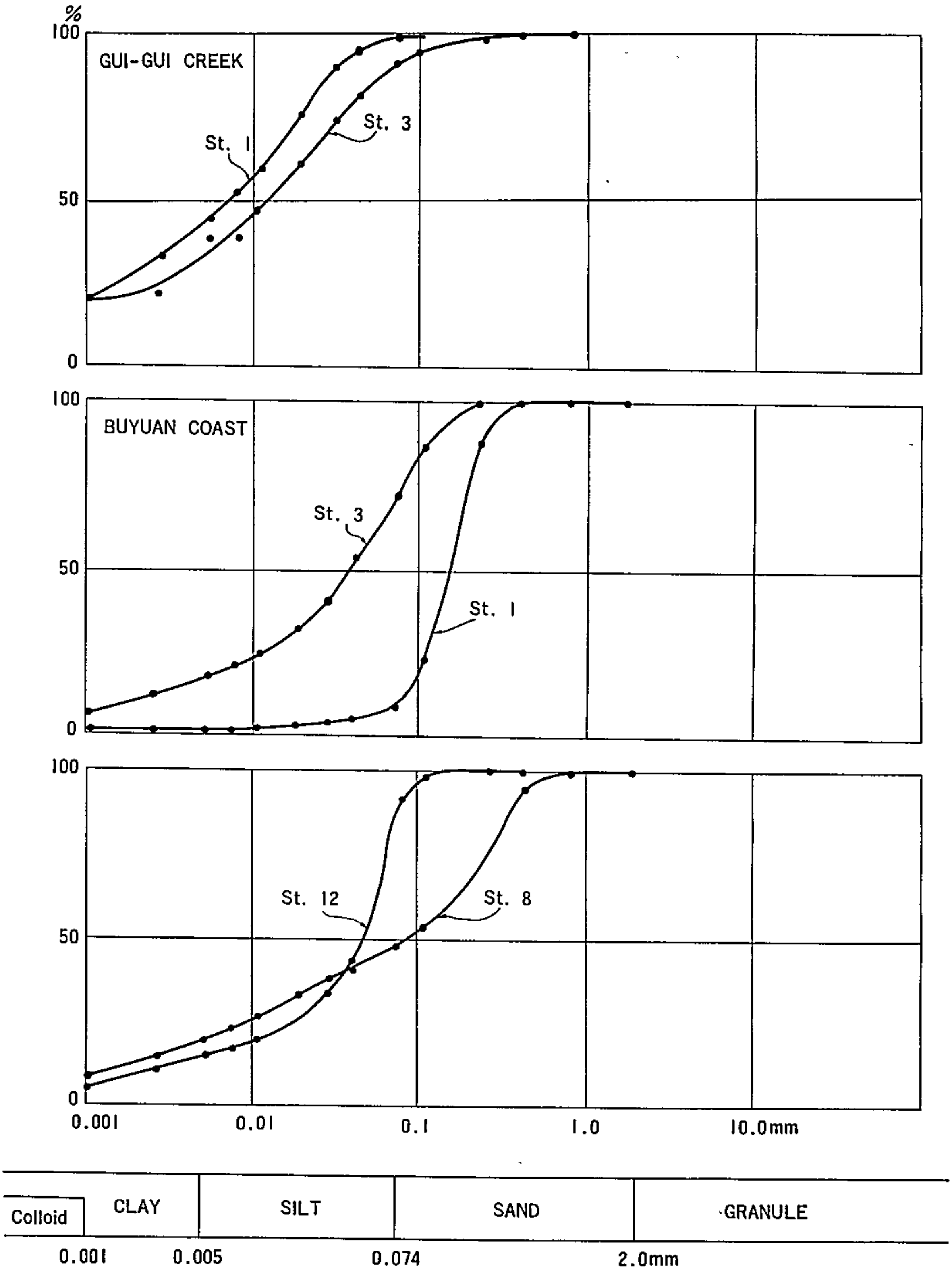


Fig. 10. Diagram drawings to illustrate the principales for the calculation of tidal range and the amount of water taken to and drawn from the pond. For the symbols used, see text. A: Observed tidal curve (a) and the same drawn from the Table at Standard Port. B: Relation of the tidal curve to the level of pond water. C: Relation of repeated (times) handlings of the gate to the level of pond water and to the area of the gate.

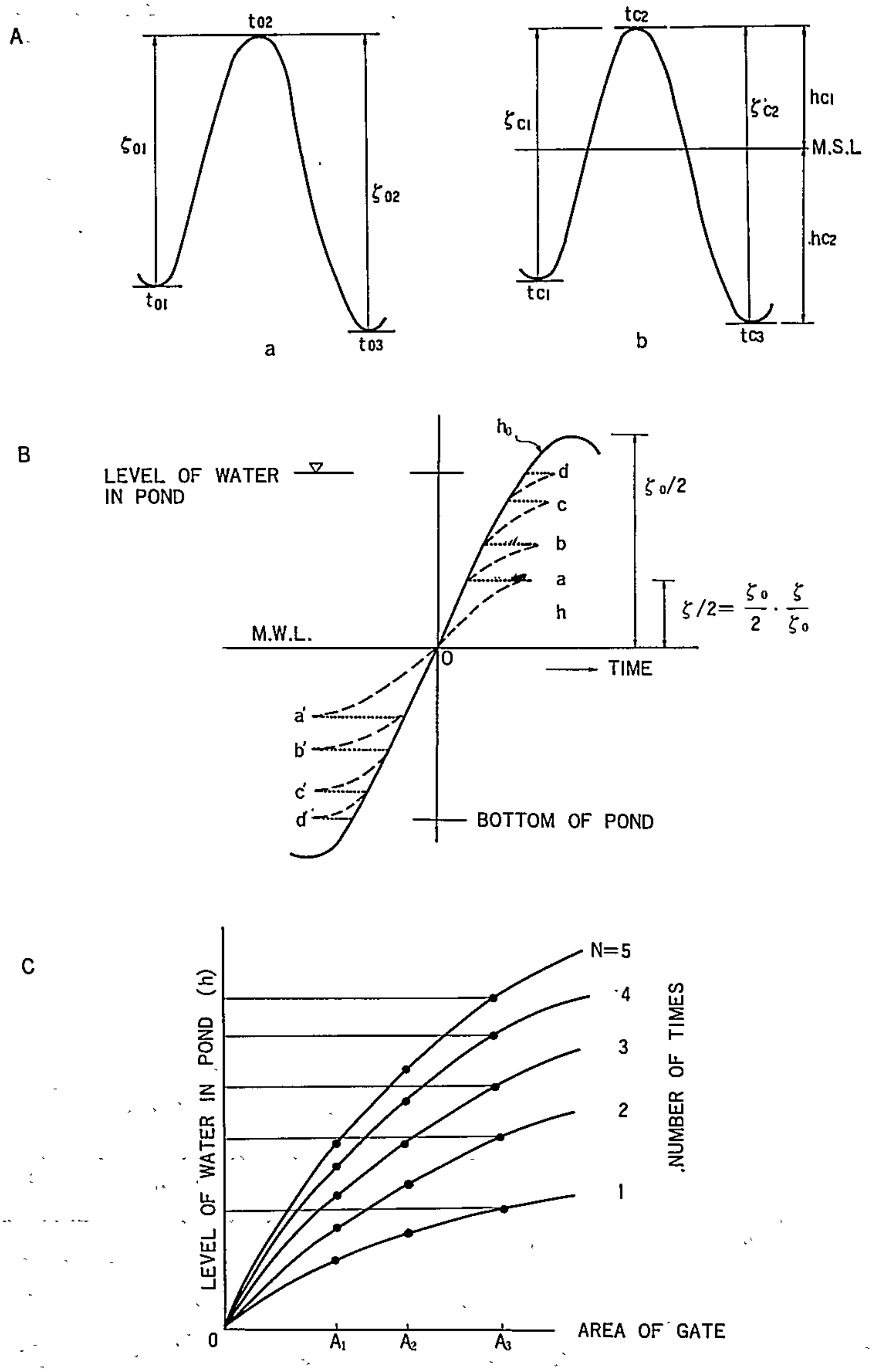
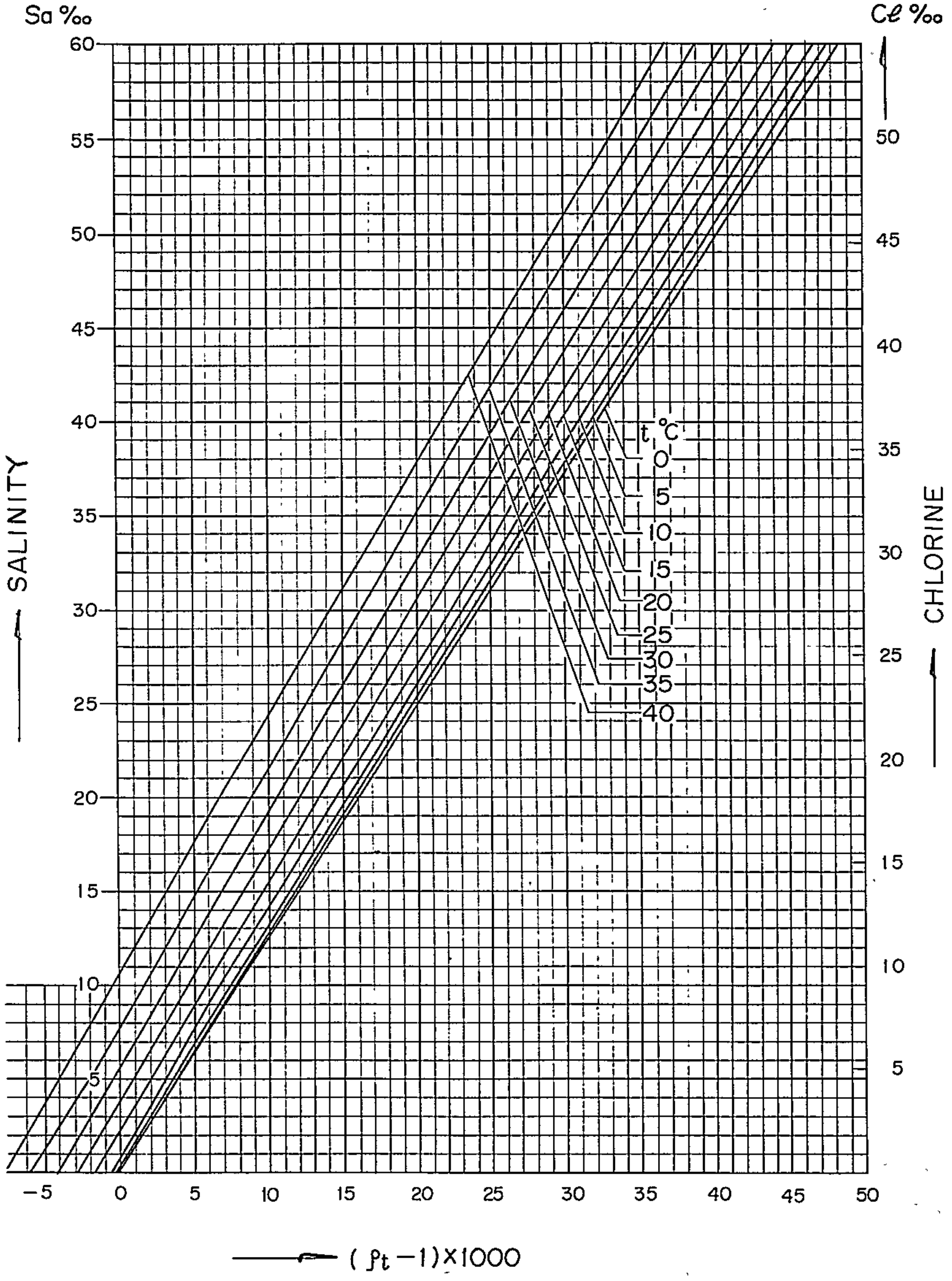


Fig. 11. A graph designed for the conversion from observed S. G. readings to salinity and chlorine concentration of the water under given temperatures. Emended from Fig. 26 in the report of the first survey. Drawn by Makoto Nakamura.



MEMORANDUM: BASIC PLAN ON FISH PONDS AND BUILDINGS OF THE SEAFDEC PROJECT AT LEGANES, PANAY ISLAND, PHILIPPINES

(with 4 Figures)

Forwarded to Dean, College of Fisheries,
University of Philippines, November 26,
1971

by THE JAPANESE SURVEY TEAM

MEMORANDUM
Basic Plan on Fish Ponds and
Buildings of the SEAFDEC Project
at Leganes, Panay Island

To Dean, College of Fisheries
University of Philippines

Japanese Survey Team
November 26, 1971

On the basis of the informal understanding reached between the Philippine representatives and the Japanese survey team, on August 27 and 30, 1971, the basic plan for fish ponds and buildings are forwarded for consideration with four sheets.

This basic plan is essentially a refinement of the proposals made in the Draft Report submitted in June 1971, and is drawn up with the desirable effectiveness of the project from the technical viewpoint as its main consideration. The survey team has not fully considered its financial aspect. It will be noted that the scale of the buildings thus exceeds that of the original plan.

1. Buildings : (For specification, see 4 sheets attached)

1) It is considered that the facilities to be set up in accordance with the Philippine plan, which can be used jointly, should naturally be coordinated with the facilities under the SEAFDEC plan. However since it was not possible to hold concrete discussions on the question of a joint use of facilities, the proposals under the basic plan are for exclusive SEAFDEC use.

2) It will be noted that the proposed size of the SEAFDEC facilities will occupy the total land area reserved for buildings. In the implementation of the plan, however, it is considered that adjustment with the Philippine plan for facilities along the following lines would be necessary;

a) Should it turn out to be desirable to build the National and the SEAFDEC facilities separately, the SEAFDEC buildings will not necessarily have to use the building site suggested in the present plan.

b) In the event buildings of both the Philippine and the SEAFDEC plans are constructed within the present planned land area, a single building containing the number of stories or separate buildings for both could be constructed. However, it is recommended that due consideration be given to maintain adequate independence in the administration and maintenance of both facilities.

2. Fish Ponds:

1) Main canal system

a) The layout of canal system shall be based on Fig. 21 and Fig. 25 of the said report;

b) The cross-section of main canal MC1 shall be designed as shown in Fig. 20. The surface of each canal from the bottom to M.H.H.W. (181 cm) shall be reinforced by concrete block. The gradient of its bottom shall be at the ratio of 1 to 3,000. This, its elevation at the remotest point from Gui-gui Creek estimated to be -37 cm;

c) Main canals MC3 and MC2 adjoining the Jalaud river shall serve also for the collectionoof fishes. Therefore, Fig. 20 should be modified so as to make the bottom elevation 0.0 and the gradient 0. The sides of the canal between the gate of MC3 and the river shall be protected by concrete blocks;

d) Main gates G1 to G4 shall respectively consist of 4 reams of box culverts of 1.5 m square which are embedded in the ground. The doors of these gates shall be wooden-made and the frames fastened by steel band. Hand hoisting gear shall be installed to move the doors;

e) Cross section of the dike of Gui-gui Creek shall be designed similar to that of MC1 and its entire sides shall be protected by concrete.

2) Ponds

a) The layout of ponds shall be based on Fig. 25 in the report;

b) The bottom of the ditch to the ponds of 1,000 m^2 and 500 m^2 shall be 2.0 m deep. The gradient of its side shall be 1 to 2 and the elevation of its bottom 0.0 high. The top width of the dike shall be 2.0 m and the elevation of its upper part 300 cm, and its sides shall not be protected;

c) The slope of the side of 9,000 m^2 ha pond shall be 1 to 2. The elevation of the bottom of the pond shall be M.H.L.W. (40 cm) and the bottom shall be graded toward MC2. The elevation of the bottom shall be +40 cm at the side of MC2 and +60 cm at the side of MC1;

d) The gate of each pond shall be designed as shown in Fig. 24. The diameter of culvert pipe of each pond is shown below:

Pond	Gate to MC1	Gate to MC2
9,000 m^2	100 cm	40 cm
1,000 m^2	40 cm	30 cm
500 m^2	30 cm	30 cm

e) The screen at the pond side of the gate of each pond shall be 3 times wider than the diameter of the pipe, and the screen shall be located from the mouth of pipe at the distance 3 times wider than the diameter of the pipe.

3) Road and Bridge

a) Main roads shall be protected by an asphalt surface. The dike of MC1 shall be constructed to permit use by moter-vehicles and lead to the buildings of the laboratory;

b) Two bridges of 3.5 m width shall be built for MC1 (central part and Gui-gui Creek's side of the canal) and other two for MC2.

It is added that the amount required by the SEAFDEC Project of fresh water originating from the deep well is estimated to be about 1.5 times more than that required by the Philippine National Project including the water needed for dormitory.

OUTLINE SPECIFICATION FOR BUILDING

1. Architectural

Exterior finishes:

Berm and corridors floor . . . . . Ceramic tile
Base and wall . . . . Mortar ceramic facing spray
Roof (undercoating water proof mortar) . . . . . Roof of tiles
Sash (with window) . . . . Gyro-type aluminum, frame screen
Suncontrol . . . . Louver-type aluminum, frame screen

Interior finishes:

Floor . . . . Ceramic tile
Base . . . . Ceramic tile (sanitary)
Wall . . . . Plastic wall covering
Ceiling . . . . . Asbeston-board with acoustic

2. Structural

Foundation . . . . Direct

Footing and tie-beam . . Reinforced concrete construction

Column and beam, girders . Steel frame construction

Roof and wall . . . . . Autoclaved lightweight concrete panel

3. Mechanical

Air-conditioning services:

Laboratories, experiment-rooms, study-rooms, dark-room . . .
Central packaged air-conditioner, 20 Hp X 1

Refrigerator . . . . .
Freeze room, cold-air chamber, cold storage, 20 Hp X 1

Other rooms . . . . .
Ceiling fan (natural ventilation) 0. 75 kw/set

Plumbing:

Water supply system	Pumps 3. 5 kw X 4 (river and sea water)
Butane gas sytem	Blowers 3. 5 kw 2
Drainage system	
Etc.	

4. Electrical

Power source: Two sets of generators (with transformer) 200 kv X 2

Electric circuits: 3 phase 200 v and 1 phase 100 v

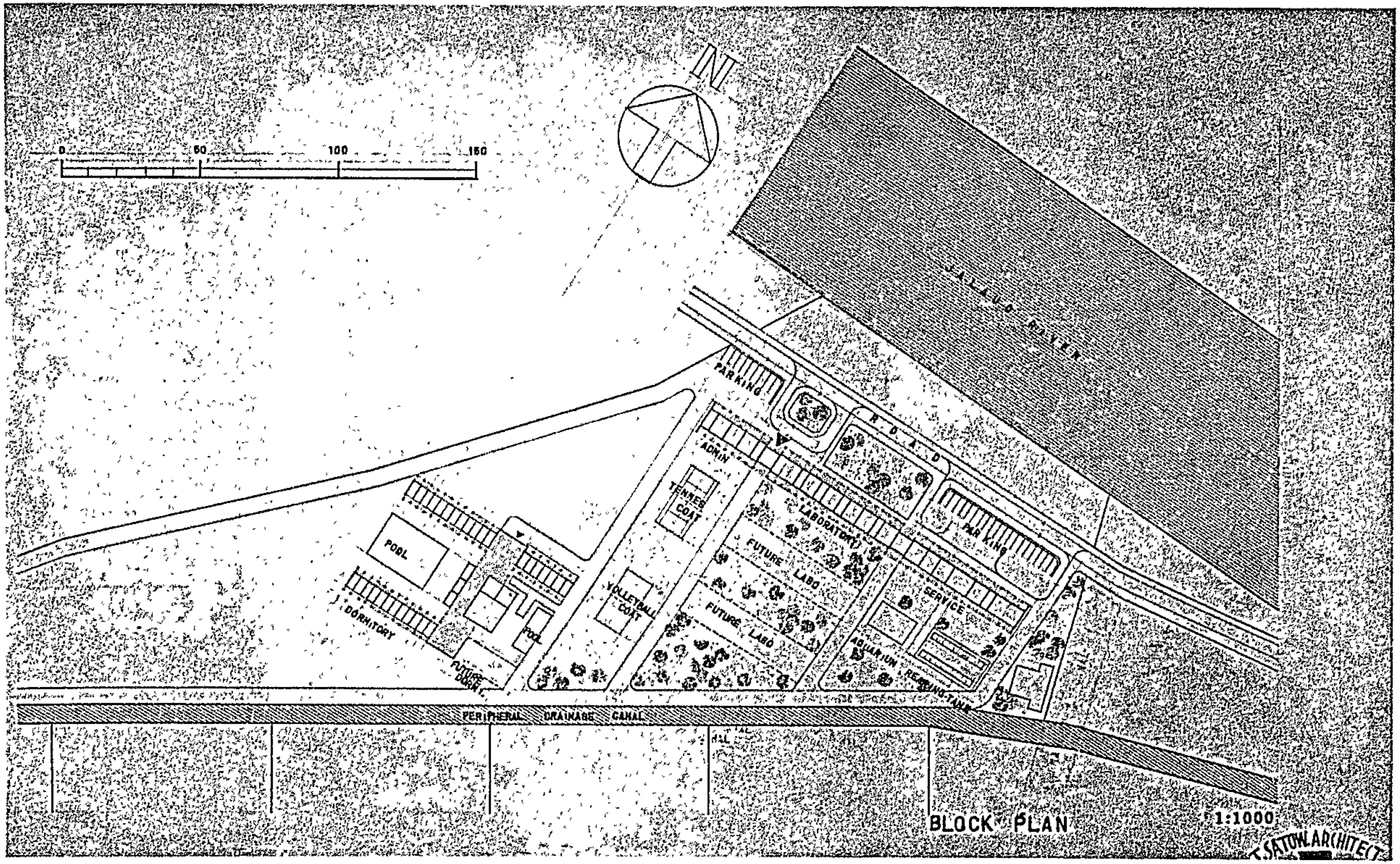
Lighting:

Lighting fixuture
Laboratories and experiment-rooms: Incandescent lamp
Other rooms: Flourecent lamp
Lighting level

General rooms 200 lux
Laboratories and Experiment-rooms 500 lux
Other rooms 200 lux

Communication system:

Telephone, loud-speaker, radio-transmitter, etc.



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JALAUD RIVER
ROAD
PARKING
ADMIN
TENNES COAT
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SERVICE
AQUARIUM
REARING TANK
VOLLEYBALL COAT
POOL
POOL
DORMITORY
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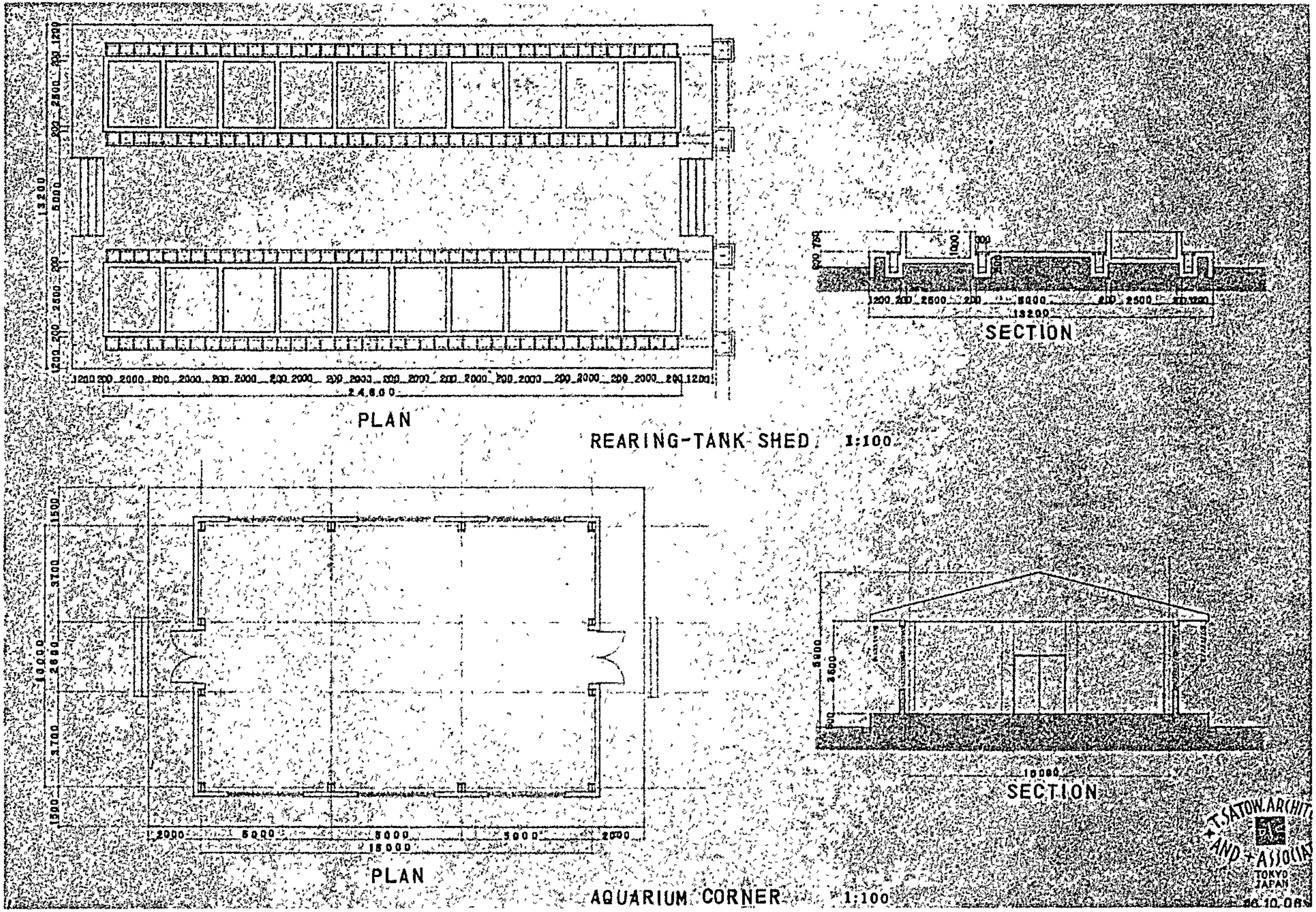
PERIPHERAL DRAINAGE CANAL
BLOCK PLAN
1:1000
T. SATOW. ARCHITECT


PLAN
SECTION
REARING-TANK SHED 1:100
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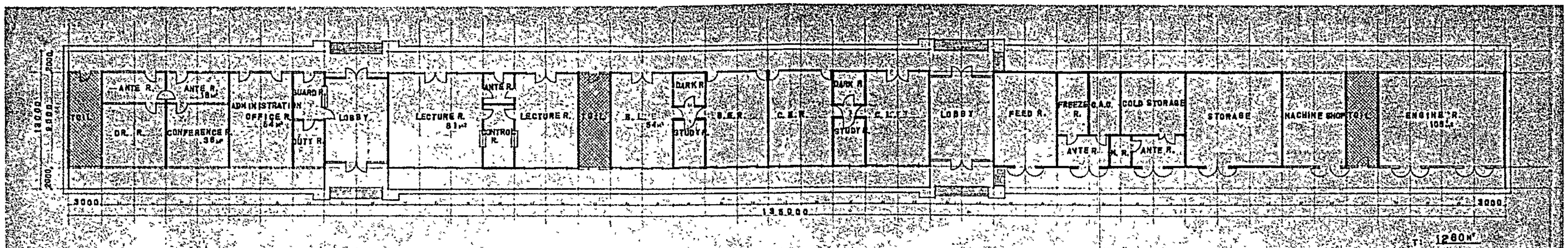
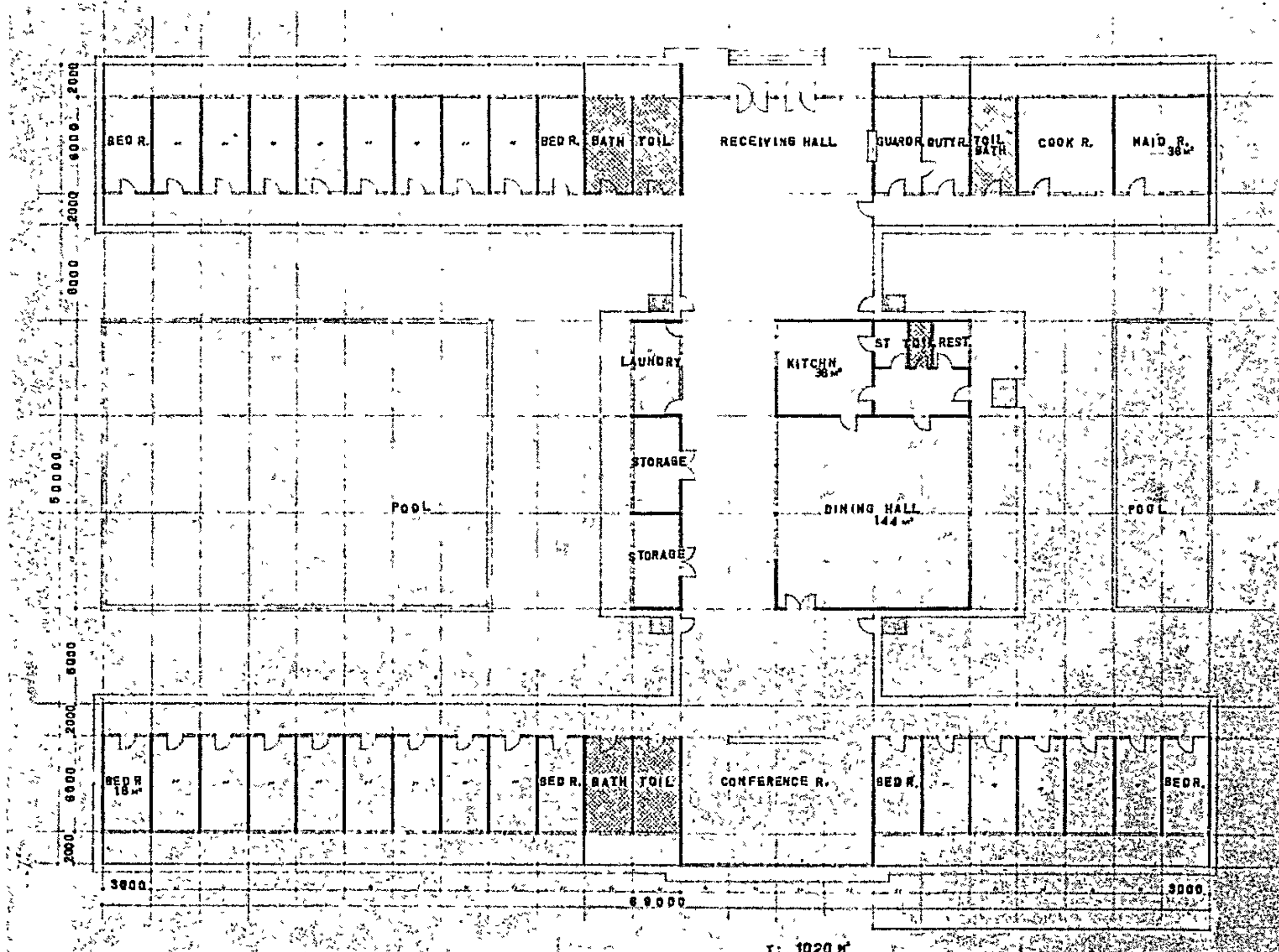
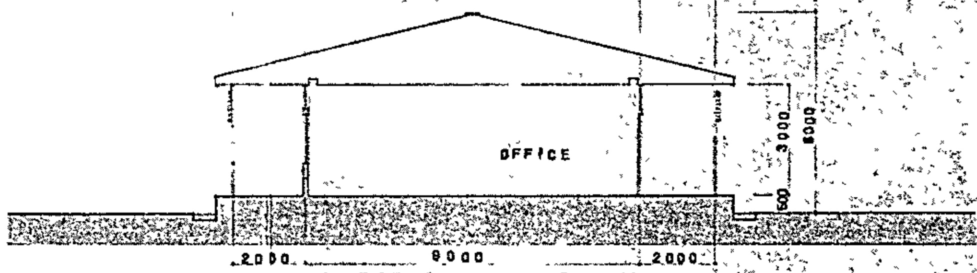


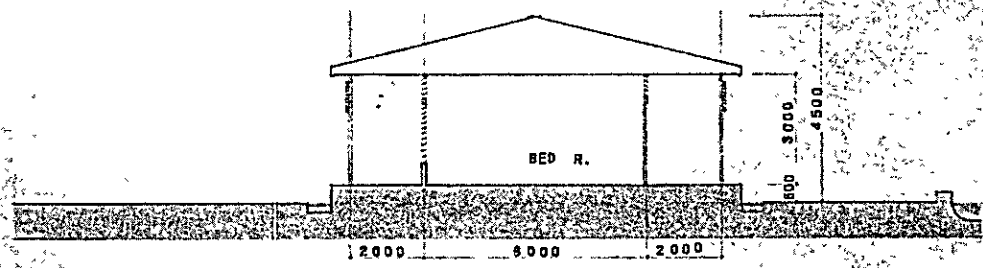
LABORATORY PLAN 1:200



DORMITORY PLAN 1:200



LABORATORY SECTION 1:100



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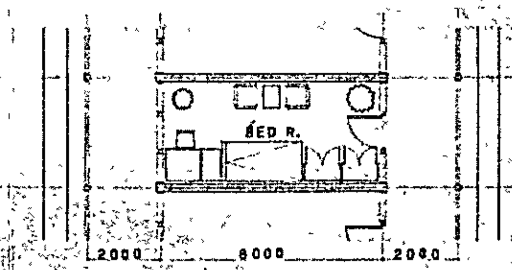

DORMITORY PLAN 1:100

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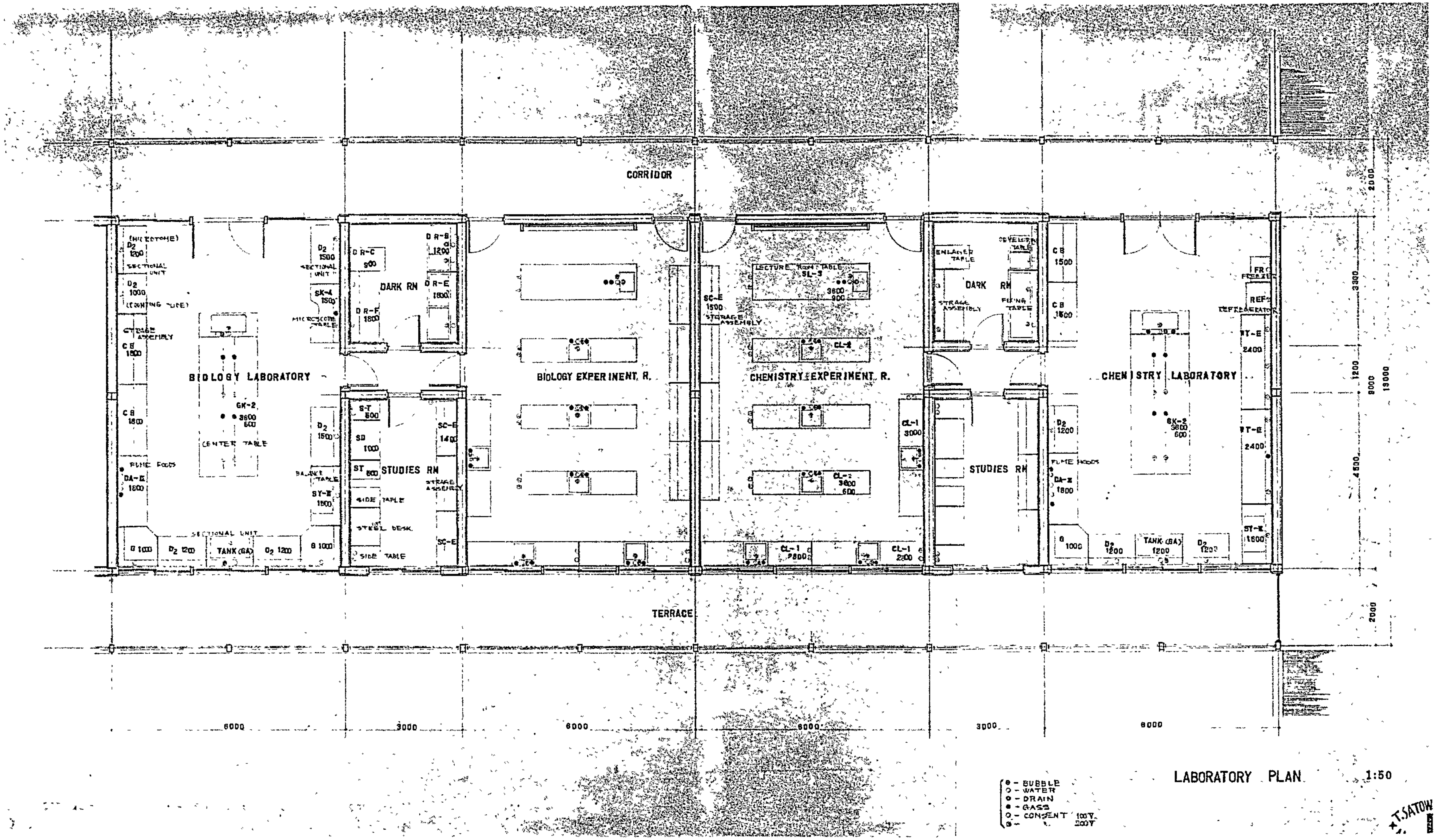
CORRIDOR
BIOLOGY LABORATORY
DARK RM
STUDIES RM
BIOLOGY EXPERIMENT. R.
CHEMISTRY EXPERIMENT. R.
DARK RM
STUDIES RM
CHEMISTRY LABORATORY
CENTER TABLE
SECTIONAL UNIT
STORAGE ASSEMBLY
FUME HOODS
TERRACE
6000
3000
6000
6000
3000
6000
LABORATORY PLAN 1:50
BUBBLE
WATER
DRAIN
GASS
CONSENT 100V 200V
T.SATOW