REPUBLIC OF THE PHILIPPINES

BASIC STUDY ON MASS INDUSTRIAL WATER CONSUMING INDUSTRIES

JULY 1971

prepared for

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

by

JAPANESE SURVEY TEAM FOR MASS INDUSTRIAL
WATER CONSUMING INDUSTRIES IN THE PHILIPPINES

PREFACE

The Government of Japan, in response to the request of the Government of the Republic of the Philippines, undertook to conduct a basic survey for the mass industrial water consuming industries in the Republic of the Philippines and entrusted the execution of the survey to the Overseas Technical Cooperation Agency.

Being cognizant of the importance and the feasibility of the project, the Agency organized a survey team comprising seven members, headed by Mr. Takeshi Hidaka and sent it to the Philippines for a period of 30 days from February 23 to March 24, 1971.

The team made a survey on water resources, sugar industries, pulp and paper industries, chemicals and the meteorology and collected the related data mainly in the Luzon and Negros islands.

Upon returning to Japan, the team analyzed the data and findings and came to the following conclusions.

(1) The rationalization of the sugar industry is required from the standpoint of the Philippine economy.

(2) In line with the above, bagasse pulp industry can technically be started and be raised as an export industry in the future.

It is my sincere hope that this report will prove helpful to the promotion of the bagasse pulp industry and its development in the future as well as to the further advancement of economic relationship and friendship between Japan and the Republic of the Philippines.

Finally, I wish to take this opportunity to express my heartfelt gratitude to the officials of the Government of the Republic of the Philippines for their whole hearted cooperation and support extended to the team in the execution of the survey.

July 1971

K. Tatsuke

Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

JICA LIBRARY
1045656[4]

国際協力事業団	
受入月日 '84. 3. 23	118
	60
登録No. 01776	KE

June, 1971

Mr. Keiichi Tatsuke,
Director General,
Overseas Technical Cooperation Agency,
Tokyo, Japan

Dear Sir:

We are pleased to submit this report of the basic survey of the mass industrial water consuming industries and the bagasse pulp and paper manufacturing project in the Republic of the Philippines, with which we are entrusted.

The Overseas Technical Cooperation Agency dispatched the survey team comprising seven experts to the Philippines.

The team, according to the schedule, made a on-the-spot survey of the main rivers, sugar mills and chemical plants and had collected various data of water resources, sugar mills, paper, pulp, chemicals and meteorology in the Philippines through discussions and meetings with Governmental officials and the related staffs.

And the team could have submitted the interim report, based on the findings and data, to the Philippine Government and the authority concerned.

Upon arrival in Japan, the team has been analyzing the situations of the main rivers, bagasse production of sugar mills, supply and demand of chemicals, transport problem and the marketing of paper and pulp, thus evaluating the feasibility of the bagasse pulp industry.

We are happy that the report is now ready for presentation. The main emphases of this report are put on the following items.

(1) Site selection for the pulp and paper manufacturing industries on the basis of the survey of river discharge and water quality.

(2) How to promote rationalization of the sugar industries in the Philippines; One of the ways is the manufacturing of paper and bagasse pulp, using bagasse as raw materials.

(3) Bagasse has been supposed abundantly produced and its value almost zero. Our survey proved that the industrialization of bagasse pulp depends on the price and the quantity of bagasse by means of converting the fuel to crude oil.

(4) The integrated industrial area, where sugar mills, paper plant and the chemical plant necessary for the paper manufacturing are located near each other should be formed.

We could have a grasp of water resources in the Philippines through the survey and therefore were able to suggest two plans for paper manufacturing using bagasse. We came to the conclusion that both plans for bagasse pulp plant of 200 MT/D capacity and wood-free fine paper manufacturing plant of 110 MT/D capacity using the 100 MT/D bagasse as raw material are feasible.

We are very happy if this report could be helpful in executing the bagasse pulp project and could be an example for conducting this sort of survey. Though the further detailed survey on market research, production cost and selling price, is of course required for bagasse pulp project, this current survey could be the first step-out in materializing the bagasse pulp plant.

Finally I should like to take this opportunity to express our hearty gratitude to the Philippine Government and the authorities concerned who have shown to us kind cooperation and assistance. Our acknowledgement is also extended to the Japanese Embassy in the Philippines, Ministry of International Trade and Industry, Ministry of Foreign Affairs, Japan Consulting Institute and the Overseas Technical Cooperation Agency.

Yours faithfully,

T. Hidaka

Takeshi Hidaka
Head, Japanese Survey Team
for Mass Industrial Water
Consuming Industries
in the Philippines

Acknowledgement to the Cooperative Members

We should like to express our heartfelt gratitudes to the Philippine Government Authorities, and our thanks to the Governmental officials who have supported and helped our team by sending the counterparts, to accomplish our survey and to provide the team with every kind of data available, which are listed below.

Presidential Economic Staff (PES)
Board of Investment (BCI)
Forest Products Research and Industrial Development Commission (FORPRDECOM)
Bureau of Public Works (BPW)
National Economic Council (NEC)
Weather Bureau and Other Government Agencies
Philippine Sugar Association

Specially we should like to express our heartfelt gratitudes to the gentlemen who accompanied with our survey team, and also colaborated with us to accomplish the pleliminary draft report.

Mr. Susumu Mishima	Chief of JCI Office in Manila
Mr. Rafael Fajardo	Presidental Economic Staff
Mr. Carl John Matriano	Board of Investment
Mr. Enrique Amio	Forest Products Research and Industrial Development Commission

We also should like to express our acknowledgement to the Governmental Staffs of the Cities and members of the Sugar Centrals, Pulp and Paper Plants, and Chemical Plants, who offered to the team the opportunities of survey and discussions.

1-1 THE OBJECTIVE OF THE SURVEY

In accordance with the request of the Philippine Government, the present Survey Team was sent to the Philippines by the recommendation of the Ministry of International Trade and Industry (MITI) and Overseas Technical Cooperation Agency (OTCA) in Japan as a part of the technical assistance for developing countries. This feasibility study, which is done from the standpoint of the special field of correlated industries in Japan, is hoped to be able to serve as the guide line and reference to accomplish the project in the Philippines.

The objective of the survey is to present suggestions to the Philippine Government as to the following items:

(1) As a model case of mass industrial water consuming industry, to make a feasibility study of pulp and paper plant using bagasse produced in the sugar mills

(2) Referring the data collected during the survey of sugar mills, water resources, chemicals correlated with pulp and paper production, to suggest the Philippine Government the feasibility and technical consideration for the planning of pulp and paper plant and also the project of this kind.

The surveyed areas cover the many islands, and special survey was made in the following areas:

(1) Southern part of Luzon Island
(2) Negros, Occidental and Oriental
(3) Panay Island
(4) Mindanao Island

Period of Survey: From Feb. 23 to Mar. 24, 1971 (for one month)

The main items surveyed:

1) The future possibility of the development of pulp and paper industry and correlated chemical industry

2) The technical and marketing aspects of the pulp and paper industry using the bagasse as the raw materials, and the procedures of realizing the project

3) To collect the data and informations, and to study the availability of bagasse and bleaching chemicals as the important raw materials and chemicals for the production of pulp and paper

1-2 COMPOSITION OF THE SURVEY TEAM

Composition of the Survey Team and names of members are as follows:

Chief of the team (General, Chemistry)

Takeshi Hidaka
Date of birth: Jan. 15, 1904
Graduated Physics, Physical Science Faculty,
Tokyo Imperial University
Former Senior Managing Director of
Nissan Chemical Industry Co., Ltd.
Chemical Consultant

Member (Civil Engineering)

Yutaka Kondo
Date of birth: Jan. 1, 1916
Graduated Civil Engineering Faculty of
Nippon-Daigaku Technical College
Civil Engineer, Jujo Kaihatsu Co., Ltd.

Member (Mechanics)

Yasuji Mori
Date of birth: Jan. 5, 1929
Graduated Mechanics Faculty of
Tokyo Technical University
Development Engineer, Jujo Paper Co., Ltd.

Member (Process)

Michihiro Nakura
Date of birth: Jan. 5, 1930
Graduated Forestry Faculty, Tokyo University
Technical Investigation Engineer, Jujo Paper Co., Ltd.

Memeber (Economics)

Hiroaki Arakawa
Date of birth: Mar. 16, 1935
Graduated Economics Faculty, Keio University
Foreign Trade Section,Manager, Jujo Paper Co., Ltd.

Member (Industrial Water)

Teizaburo Umehara
Date of birth: Jan. 30, 1908
Graduated Technology Faculty, Kyoto University
Director, Nihon Suido Consultant Co., Ltd.

Member (Marketing Research)

Masahiko Ieda
Date of birth: Nov. 1, 1938
Graduated Economics Faculty, Gakushuin University
San Petro College
Liaison Officer of Manila Office,
Japan Consulting Institute

1-3 ITINERARY OF SURVEY TEAM

The Survey Team visited and surveyed main rivers, sugar centrals, paper and pulp mills and chemical factories in the Philippines.

On 23rd March, the Survey Team submitted draft summary report to the Philippine Government through PES, then completed whole schedule and returned Japan on 25th March. Itinerary and meeting held are shown below:

Itinerary of Survey Team

Manila

(1) Feb. 23 Left Haneda, at 12:00 by KLM 862
Arr. Manila

(2) Feb. 24 (The 2nd day)

1) Courtesy calls to the Embassy of Japan, Japan Consulting Institute Manila Office, and Overseas Technical Cooperation Agency Manila Office

2) Held a meeting at JCI office to finalize the itinerary and terms of reference of the team

3) Board of Investment (BOI)
Department of Foreign Affairs (DFA)
National Economic Council (NEC)

(3) Feb. 25 (The 3rd day)

Courtesy call to the Presidental Economic Staff (PES)
Pre-Survey discussion with representatives from the private sectors and government agencies:

1) Pulp and Paper Association of the Philippines
2) FORPRIDECOM (woods and forestry)
3) National Economic Council (NEC)
4) Bureau of Public Works
5) Presidental Economic Staff (PES)

Luzon

(4) Feb. 26 (The 4th day)

1) Laguna, Batangas (Luzon Island)
2) Canlubang Sugar Estate
3) Laguna Lake
4) Batangas Sugar Mill
Visited and surveyed above.
5) Inspection tour of the river water intake
6) Surveyed Binambang River.

Botolan, Zambalos

(5) Feb. 27 (The 5th day)

1) Visited Central Azucarera de Bataan Incorporada.
2) Inspected water intake system and Bucao River.

Iligan, Lanao de Orte

(6) Feb. 28 (The 6th day)

1) Visited Maria Cristina Hydroelectric Plant
2) Observed Agus River.
3) Mabuhay Vinyl and inspected the Caustic Soda Plant.
4) Visited Rustan Pulp and Paper Mill.
5) Inspected water intake system of each river.
6) Inspected water intake system of the Agus River.

Mactan, Cebu Island

(7) Mar. 2 (The 8th day)

1) Held a meeting to review, compared and correlated data obtained from areas and rivers.
2) Transferred to Dumaguete.

Dumaguete City, Negros Oriental

(8) Mar. 3 (The 9th day)

1) Visited Central Azucarera de Bais.

Bacolod, Negros Occidental

(9) Mar. 4 (The 10th day)

1) Transferred to Bacolod.

Bacolod, Negros Occidental

(10) Mar. 5 - Mar. 9

Mar. 5 (the 11th day)

1) Visited Lopez Sugar Central.
2) Visited Victorias Sugar Mill.
3) Observed Himogaan River and secured water samples for analysis.
4) Observed Sicaba River and secured water samples for analysis.
5) Observed Malogo River and secured water samples for analysis.

Mar. 6 (the 12th day)

1) Visited Ma-ao Sugar Central.
2) Observed Bago River and secured water samples for analysis.

3) Visited Central Azucarera de Carlota.
4) Inspected the sugar (bulk) shipping wharf owned jointly by Ma-ao, Bacolod-Muricia, Talisay-Silay Sugar Centrals.
5) Inspected Pulpandan Port.

Mar. 7 (the 13th day)

Held a meeting to compare, evaluate and correlate information gathered from areas visited.

Mar. 8 (the 14th day)

1) Visited Binalbagan-Isabela Sugar Company (BISCOM).
2) Observed Binalbagan River and secured water samples for analysis.
3) Observed Ilog River and secured water samples for analysis.
4) Proceeded to Southern Negros Sugar Development Company, and made a round of the mill.
5) Inspected the bulk shipping station of BISCOM in Hinigaran.

Panay

(11) Mar. 9 - Mar. 11

Mar. 9 (the 15th day)

1) Transferred to Iloilo City.

Mar. 10 (the 16th da6)

1) Observed Jalaur River and secured water samples for analysis.
2) Inspected water intake system of mouth of Jalaur River.
3) Visited Santos-Lopez Sugar Centrals.
4) Inspected Moroboro Irrigation Dam.

Mar. 11 (the 17th day)

1) Transferred to Loxas City by railroad from Iloilo.

(12) Mar. 12 (the 18th day)

1) Paid respect to the Governor of Capiz.
2) Surveyed the surrounding areas of Capiz City.
3) Inspected Port of Caulasi.
4) Observed the Panay River.
5) Proceeded to Aklan.
6) Arrived Kalibo and made courtesy calls to the Mayor of Kalibo and Governor of Aklan.
7) Proceeded to the gauging station of Aklan River.
8) Observed the water irrigation intake system of Aklan River.

(13) Mar. 13 (the 19th day)

1) Made panel discussions with local officials of Kalibo City referring to the local development of this areas under the auspices of the Governor.
2) Returned to Manila.

Manila

(14) Mar. 14 - Mar. 24

Mar. 14 (the 20th day)

1) Arrangement of data and samples collected during the survey trip.

Mar. 15 (the 21st day)

1) Made whole day discussion at JCI office to study the informations collected.

Mar. 16 (the 22nd day)

1) Visited Bureau of Public Works to collect data.
2) Visited Water Works to collect data.

Mar. 17 (the 23rd day)

Visited the following government offices to collect data.

1) Held a meeting at Presidental Economic staff.
2) Visited Bureau of Public Works to collect data.
3) Visited National Water and Air Pollusiton Control Commission.
4) Visited Philippine Sugar Association to collect data.

Mar. 18 (the 24th day)

1) Discussion and studied data collected at JCI Manila office.

Mar. 19 (the 25th day)

1) Reviewed and compared notes on data collected with Mr. Rafel Fajardo (PES) and Mr. Carl John Matriano (BOI) at JCI office.

Mar. 20 (the 26th day)

1) Drafting the summary report

Mar. 21 (the 27th day)

1) Drafting and printing the Summary Report

Mar. 22 (the 28th day)

1) Completed the draft Summary Report.

Mar. 23 (the 29th day)

1) Submitted the draft summary report to the Philippine Government and Embassy of Japan.
2) Ceremony of submitting above report to the Philippine Government held under the auspices of Presidental Economic Staff with the governmental authorities.

3) Held meeting of the explanation and discussion referring to the draft summary report at the office of Presidental Economic Staff.

Mar. 24 (the 30th day)

1) Meeting with the President of Mabuhay Vinyl Corporation.

(15) Mar. 25 (the 31st day)

Left Manila and arrived Haneda by JAL 712.

CONCLUSIONS

After an extensive and comprehensive field investigations and from all collected data, the Survey Team arrived at the following findings. Note that owing to the short period of staying in the Philippines the Survey Team has confined its study solely on Bagasse Pulp and Paper producing using bagasse pulp as raw materials, and did not consider other raw materials such as abaca and wood for producing pulp and paper.

Hence the objectives of the present investigation are firstly to make a survey on water resources, and then to collect the data from which the general idea of rivers in the Philippines can be obtained.

Secondly the present investigation is aimed at visiting the sugar mills which produce bagasse, the machines installed and equipment used, process water, and transportation. As to these items, the Survey Team made discussions with the members of Sugar Mills.

Special considerations were given to the production and the availability of the bagasse produced in the mills.

Basing on the data of the feasibility for the enterprise to make pulp from bagasse, the Survey Team selected and proposed the suitable plant site from the stand points of water, sugar mills, necessary chemicals, raw materials, and transportation.

The Survey Team submitted two proposals of pulp and paper plants which were based on the water resources to be secured, intergrated groups of adjoining sugar centrals, bagasse production, necessary chemicals, sub-raw materials, land, manpowers, market, quality of pulp and paper produced from bagasse.

1. The Retionalization of the Sugar Industry

The rationalization of the sugar industry is one of the most important problems in the future (not so far).

One of these is the utilization of sugar-cane bagasse as raw material for the the production of pulp and paper. Of course the quality of paper is to be considered, and the fine grades paper is the most desirable one. Considering that the agreement of Laurel-Langley (sugar quota) will be terminated next year, and the rapid growth of sugar cane industries in Formosa, Hawaii, South America, and Middle South America, the Philippines sugar industry will be compelled to change.

Survey team considered that the rationalization of sugar industry in the Philippines is one of the most important problems, and therefore emphasizes the significance of the production of bagasse pulp as one of the attempts for the rationalization of sugar industry.

It is emphasized that following items are to be solved one by one for the rationalization of sugar industry, which are also closely related with the above problems.

1) Quality of paper produced from bagasse pulp
2) Market
3) Water resources, Chemicals, Utilities (specially fuel oil), production quantities of bagasse

2. Relative Position of Sugar Centrals, and Pulp and Paper Plant

The Sugar Centrals and Pulp and Paper Mills must be closely integrated, and they must be located as close as possible with each other for the benefit of utilization of joint operation or utilities, such as electric power, water, steam, boiler feed water, and fuel oil.

Transportation, plant site area, workshop, administration, housing colony, welfare facilities, and clinic can be used commonly or jointly, thus decreasing the cost to some extent.

3. Water Resources

For a bagasse pulp plant with a rated capacity 200 MT/day pulp of which 100 MT/day pulp for sales and the rest for manufacturing 110 MT/day paper, the minimum water requirement will be 1 m^3/sec. This does not include the water requirements from the sugar centrals.

In addition to these water requirement, deep well or underground water must be considered as reserve of process water, domestic use and other purposes.

It is absolutely necessary to secure the enormous water quantities of 1 m^3/sec. for enabling the establishment of pulp and paper plant. For the effective utilization of water resources, and for the minimization of the pollution problems caused by effluent water, the adoption of cooling tower for cooling hot water by circulation and mixing the cold water with the used water is indispensable.

The areas where the river water is kept as main water resources and deep well water as reserve are hot always easily found, and the Survey Team found the above facts by the inspection and survey, and reached at the conclusion that only some reivers are suitable for the plant.

4. Excess Bagasse

From the data and discussions with officers of Sugar Centrals, we believe that there is not enough bagasse available for the production of bagasse pulp with a capacity of 200 MT/day. It is even doubtful whether at the present conditions it can supply enough bagasse for a 100 MT/day bagasse pulp plant. The following consideration and procedures must first be taken for any future bagasse pulp and paper project:

1) To solve the share problems between planters and sugar mills
2) To make every effort to produce more bagasse without sacrificing sugar production (improvement of sugar cane breeding)
3) To change or convert fuel requirement from bagasse to bunker C-fuel oil.
4) To improve boilers to raise the efficiency

Before departure of the Survey Team from Japan, it had the general idea that there are much excess bagasse in the Philippines, but after the present

survey this idea were changed. Unless the above cited procedures are taken, it is thought that there are not enough excess bagasse except one or two sugar mills for the production of bagasse pulp at the capacity mentioned later.

By adopting these measures, the bagasse plant will possibly established.

5. Chemicals

Electrolysis facilities of salt and chemical plants for the production of caustic soda, chlorine, and bleaching chemicals should be installed in the plant at a capacity not exceeding the maximum requirements for chlorine. Additional caustic soda and other chemicals needed for bagasse pulping and paper-making will be purchased from the outside suppliers.

6. Raw Materials and Utilities

The following raw materials, utilities and chemicals must be obtained at the lowest possible cost:

1) Sugar cane and bagasse for pulp plant
2) Fuel oil (Bunker C-oil) as the substitution of bagasse for fuel
3) Chemicals
4) Electric power, steam, pure water as boiler feeding water, and cooling water

7. Pollution Problem

To minimize pollution problem and secure better quality pulp, bleached alkaline (soda) pulping process is recommended.

At present air and water pollution caused by sugar mills are minimal, but for a pulp and paper project in the future it is advisable to install equipments for effluent water and air treatment.

8. Transportation

The distance between the pulp and paper plant and the market must be fully considered. The cost of transportation, loading and unloading charges, storage facilities and jetty are very important items in determining the selling price of bagasse pulp and paper.

9. Market of Paper and Pulp

Bagasse pulp and paper can either be consumed locally or exported to Japan and other Southeast Asian countries so long as it can compete resonably in price and quality. The demand for bagasse pulp as direct substitute for L-BKP (Hardwood bleached kraft pulp) is expected to be considerable within the next five years. For this reason a bagasse pulp industry should be planned as soon as possible in the both senses of rationalizing the sugar industry and saving foreign currency.

Bleached alkaline (soda) pulping process is recommended for the following reasons:

1) It will produce pulp with the same quality, and being consumed locally.
2) As the begasse pulp is similar to L-BKP with rigid quality control it can be exported.

3) In case of better quality pulp being produced, the transportation cost can be reduced.
Wood free fine paper is recommended because there is a local demand for this type of paper. This demand is expected to increase with the economic growth of the Philippines. With quality control, produced paper can compete or be on a par with the quality of the paper produced in Japan, and then there is an export market.

10. Recommended Project Plan of Pulp and Paper

The Survey Team recommends two cases, which are conceivable from the various results of the survey. This recommended project plan of the plant capacity is of course not final one and is merely a proposal basing on the present situations of the every case conceivable.

In case of the project of a big scale plant, such troubles will appear as production quantities of begasse, quality of produced pulp and paper, price, and demand. Proposed plant capacity and productive capacity is as follows:

Case 1.

100 MT/day or 33,000 MT/Y bleached bagasse Slush Pulp Plant and 110 MT/day or 36,300 MT/Y Wood free fine paper Plant

1) Total investment requirement — US$18 million
2) Production cost F.O.B. Plant site — US$212/Short ton
   Operation day 330 days
   Operation efficiency 100%
3) 110 MT/day Wood free fine paper production
4) Water requirement
   Minimum requirement — 0.58 m^3/sec. from river water
   Deep well water as reserve
5) Treating faculty of effluent air and water, and other waste

Case 2.

200 MT/day bleached bagasse slush pulp plant
100 MT/day bleached bagasse pulp (for sales)
100 MT/day bleached wood free fine paper

Hence final products:

100 MT/day or 33,000 MT/year bleached bagasse pulp
110 MT/day or 36,300 MT/year bleached Wood free fine paper

1) Total investment — US$27.66 million
2) Production cost F.O.B. plant site — (100% operation)
   Pulp — US$123/Short ton
   Paper — US$200/Short ton
3) Water requirement
   Minimum requirement — 1.0 m^3/sec. from river water and deep well water as reserve
4) Treating faculty of effluent air and water, and other waste

All the above proposed plans are based on the followings:

1) Minimum economic size of bagasse plant is 100 MT/day as experienced in South America.
2) The economic scale is a 100 MT/day bagasse pulp and 110 MT/day paper production.
3) Availability of sufficient bagasse for pulp production must be assured. In this case fuel-oil substitution for bagasse as fuel to make steam or electric power is absolutely necessary.
4) Water resources (river and deep well water) are to be assured in sufficient quantity to obtain industrial water for determining the capacity of pulp and paper plant.

11. Possible Plant Sites Sutiable for Pulp and Paper Plant

Special following considerations ought to be paid in selecting and determining plant sites for possible pulp and paper plant.

1) Before the survey of plant site, the followings were considered arbitrarily.

a.	Central and Southern Luzon Island	1 plant site
b.	Mindanao Island	1 plant site
c.	Panay Island	1 plant site
d.	Negros Island	4 plant sites

2) After conducting the survey, the following areas are recommended as suitable plant sites for the establishment of bagasse pulp and paper plant, which are integrated with Sugar Centrals.

   a. Negros Island

      i. Malogo River area
      ii. Bago River area
      iii. Binalbagan River area
      iv. Ilong River area

   b. Southern Luzon Island

      i. One river area

CONTENTS

Acknowledgement to the Cooperative Members . . . . . (1)
1.1 The Objective of the Survey . . . . . (2)
1.2 Composition of the Survey Team . . . . . (3)
1.3 Itinerary of the Survey Team . . . . . (4)

Conclusion
1. The Rationalization of the Sugar Industry . . . . . (9)
2. Relative Position of Sugar Centrals, and Pulp and Paper Plant . . (10)
3. Water Resources . . . . . (10)
4. Excess Bagasse . . . . . (10)
5. Chemicals . . . . . (11)
6. Raw Materials and Utilities . . . . . (11)
7. Pollution Problem . . . . . (11)
8. Transportation . . . . . (11)
9. Market of Paper and Pulp . . . . . (11)
10. Recommended Project Plan of Pulp and Paper . . . . . (12)
11. Possible Plant Sites Suitable for Pulp and Paper Plant . . . . . (13)

Chapter 1. Water Resources
1.1 Water Resources of Rivers 1
1.1.1 General Description of the Main Rivers 1
1.1.2 Qualify of River Water 54
1.1.3 Present Use and Future Development of River Water . . . 56
1.1.4 Problem of Environment Pollution 58
1.2 Groundwater Resources 59

Chapter 2. Sugar Centrals
2.1 General Description 62
2.2 Sugar Mill 64
2.3 Survey Results of Sugar Mills 69
2.4 Quantities of Excess Bagasse 79
2.5 Situation of Excess Bagasse 83
2.6 Calculation of Calorific Value of Excess Bagasse 84
2.7 Estimation of Excess Bagasse 86

Chapter 3. Pulp and Paper Plants

3.1 General Description of Manufacturing of Pulp and Paper in the Philippines 88

3.2 Bagasse as Raw Materials 88

3.3 Process of Bagasse Pulp Making 90

3.4 Chemicals for Pulp Plant 91

Chapter 4. Market Study of Pulp and Paper

4.1 General Description of Pulp and Paper 92

4.2 Pulp and Paper Industry in the Philippines 95

Chapter 5. Economic Analysis of Pulp and Paper Plant

5.1 Species of Pulp and Paper 103

5.2 Case Study of the Two Suggested Proposals 103

Chapter 6. Chemicals for the Manufacturing of Pulp and Paper

6.1 Sugar Mill 117

6.2 Pulp Plant 117

6.3 Paper Plant 117

6.4 Basic Chemical Industries Correlated with Pulp and Paper in the Philippines 118

6.5 General Prospect of Integrated Industrial Area of Iligan . . . 123

CHAPTER 1. WATER RESOURCES

SECTION I WATER RESOURCES

1.1 Water Resources of Rivers

1.1.1 General Description of Main Rivers

For the study of water resources required under the pulp mill project using bagasse produced by the existing sugar mills, field investigations were made on the following specific rivers.

Luzon Island

(1) Bucao River (Carebi Sugar Mill)
(2) San Cristobal River (Canlubang Sugar Mill)
(3) Benabang River (Batangas Sugar Mill)

Mindanao Island

(4) Agus River (Rustan Pulp & Paper Mill)
(Mabubay Viny Corp. Plant)
(Caustic Soda Plant)

Negros Island

(5) Tanjay River (Bais Sugar Mill)
(6) Himogaan River (Lopez Sugar Mill)
(7) Mologo River (Victorias Sugar Mill)
(8) Bago River (Ma-ao Sugar Mill)
(9) Najalin River (La Carlota Sugar Mill)
(10) Binalbagan River (BISCOM Sugar Mill)
(11) Ilog River (Southern Negros Sugar Mill)

Panay Island

(12) Jalaur River (Santos-Lopez Sugar Mill)
(Passi Sugar Mill)
(New Frontier Sugar Mill)
(13) Panay River (Asturias Sugar Mill)
(14) Aklan River

Fig. 1 Map of Manila City and Vicinty

LUZON ISLAND

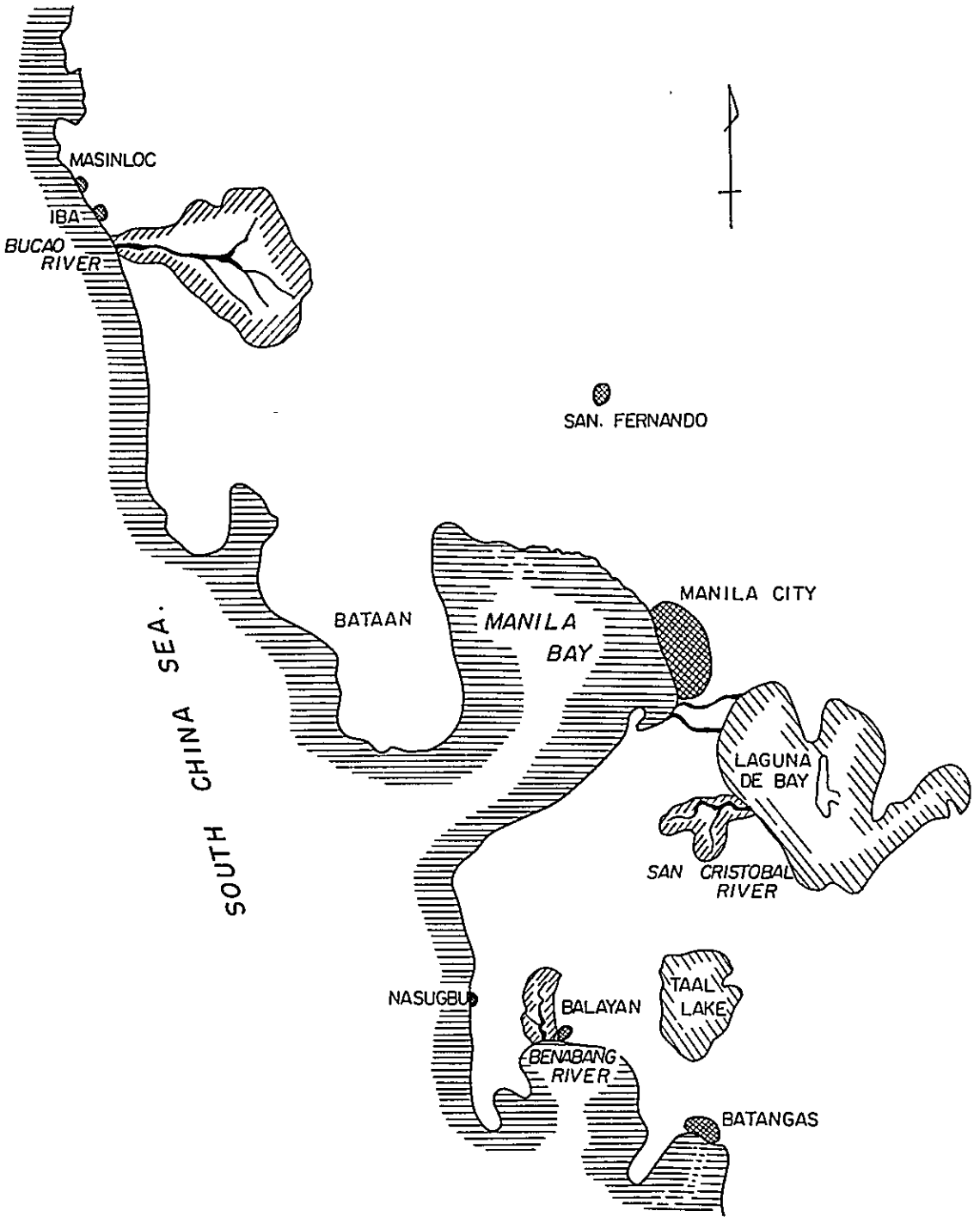


Fig. 2 Map of Iligan City and Vicinity

MINDANAO ISLAND

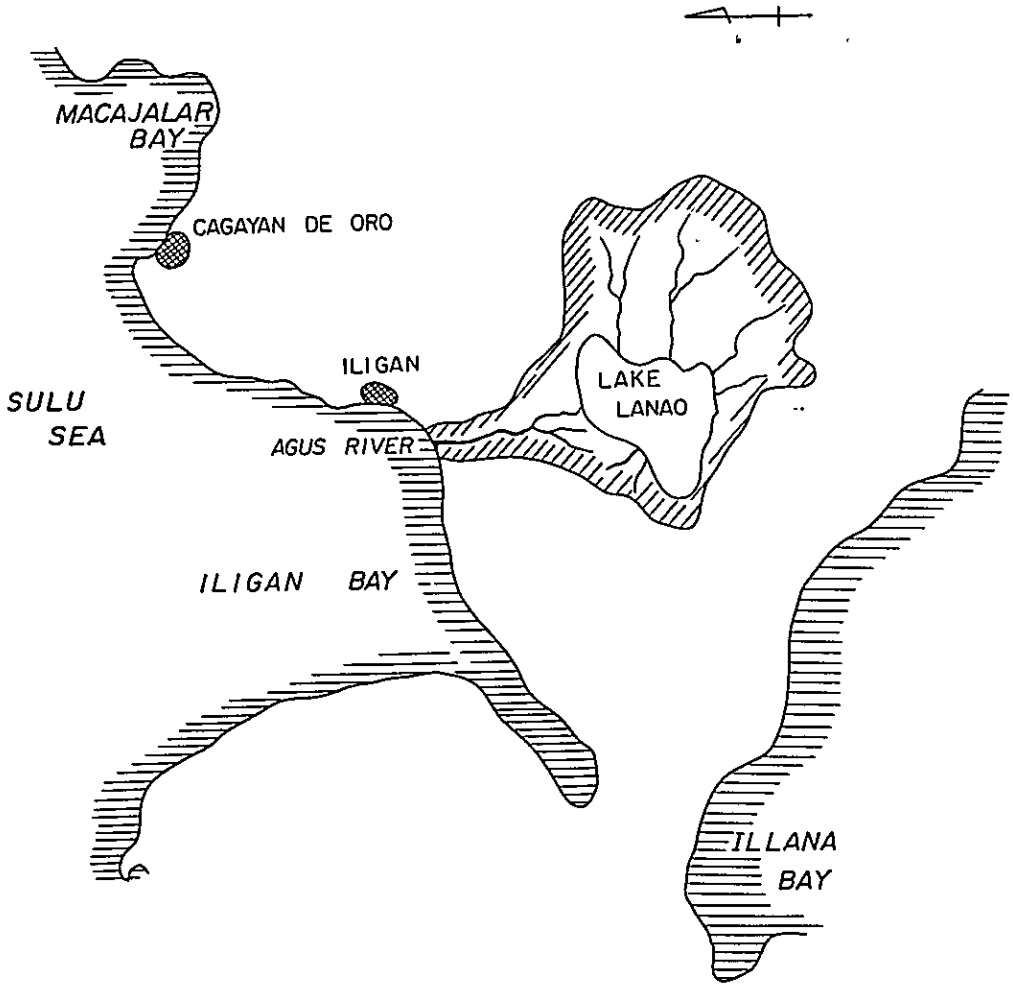


Fig.3 NEGROS ISLAND

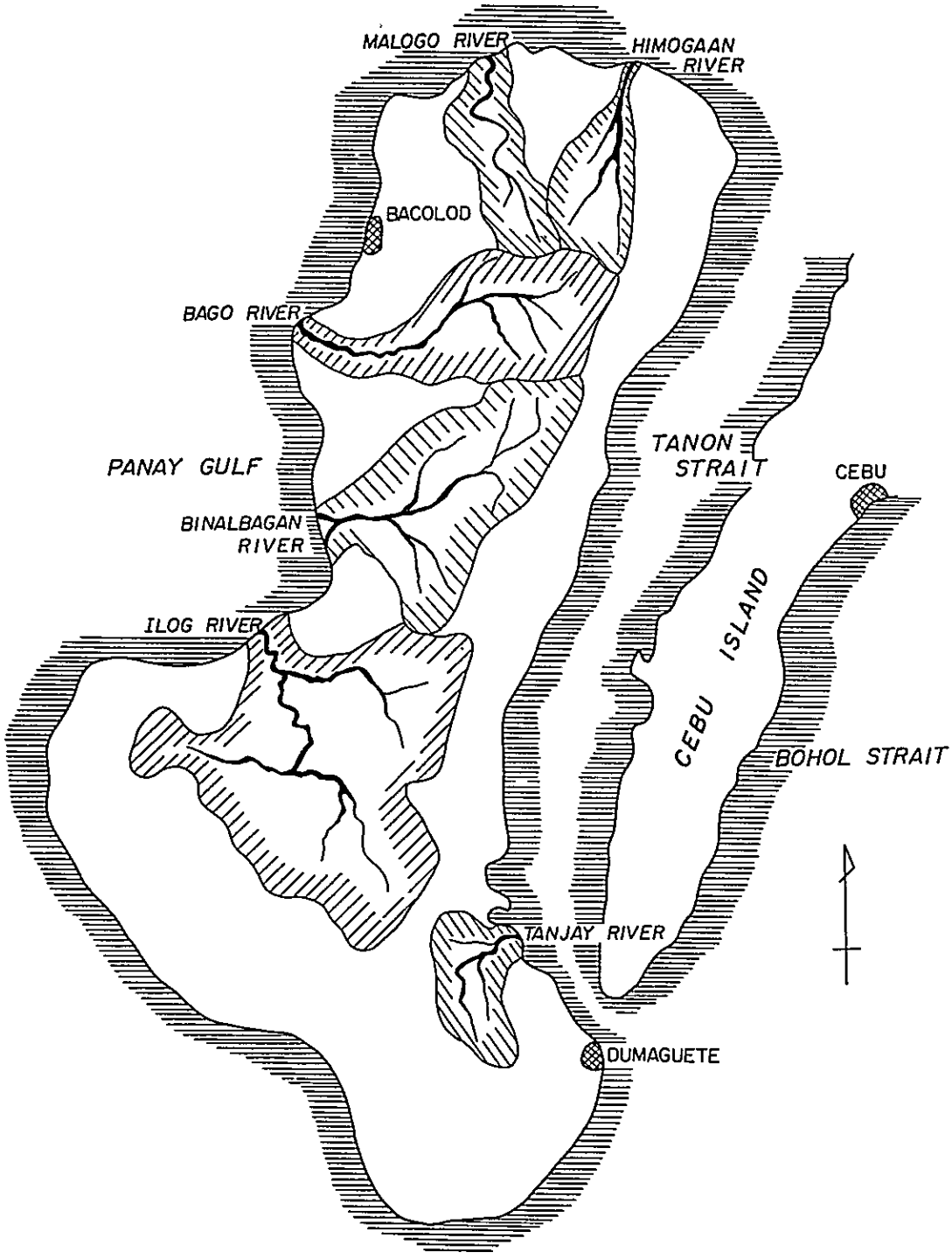
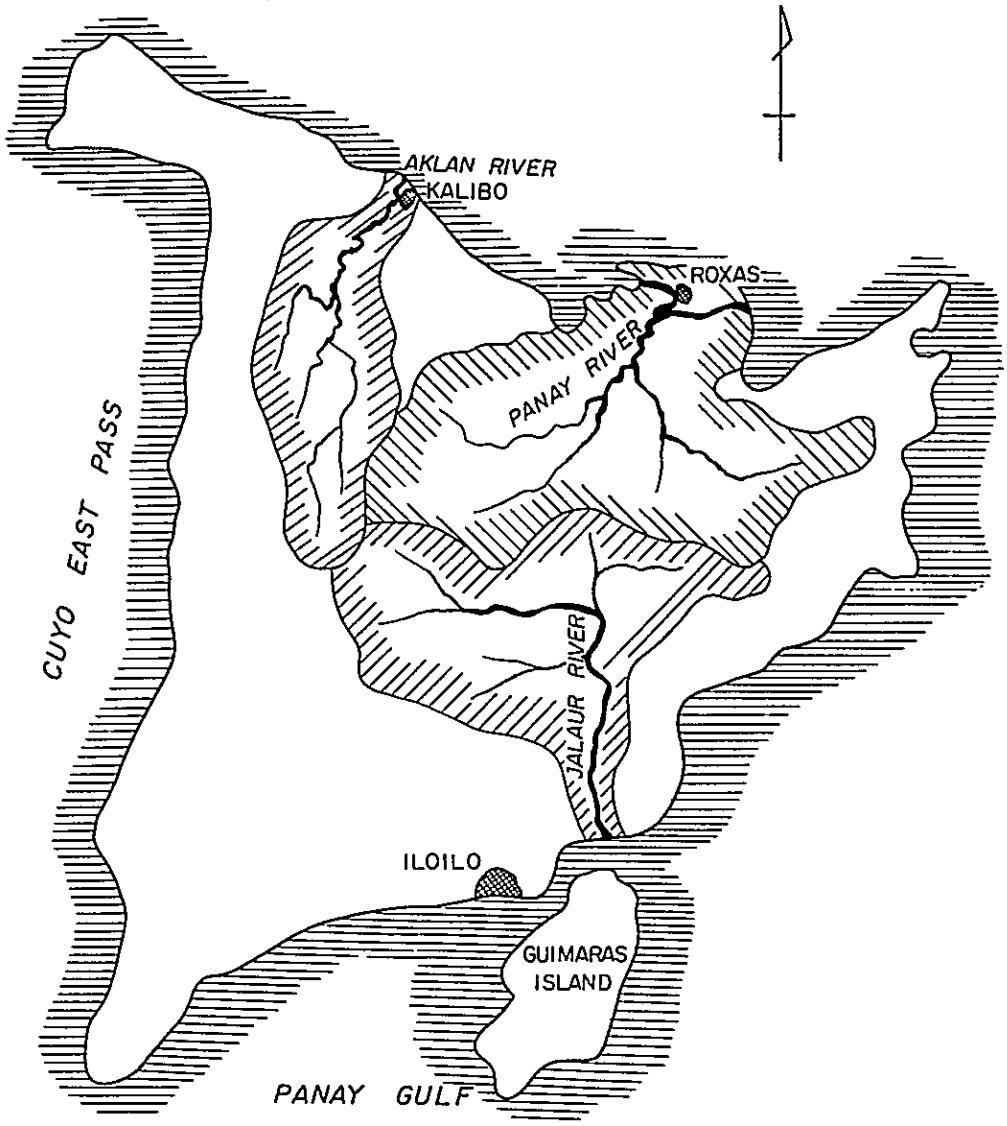
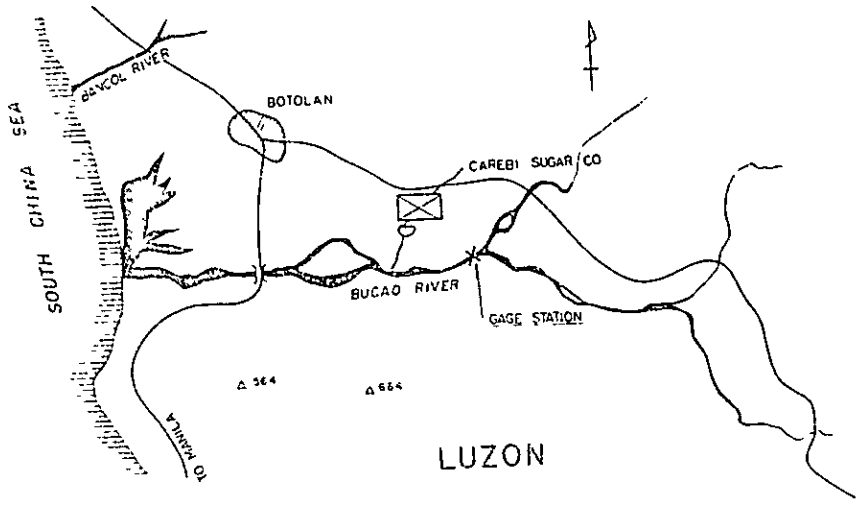


Fig. 4 PANAY ISLAND



(1) Bucao River

Fig 5



This river flows approximately 200 km northwest of Manila City, Luzon Island, and discharges into the South China Sea. The river is over 100 m in width and has close similarity to the rivers in Japan in that it is reich in sand and gravel. As far as the river bed is concerned, it is the only sand river among the rivers surveyed, the type which is rare and seldom seen in the Philippines.

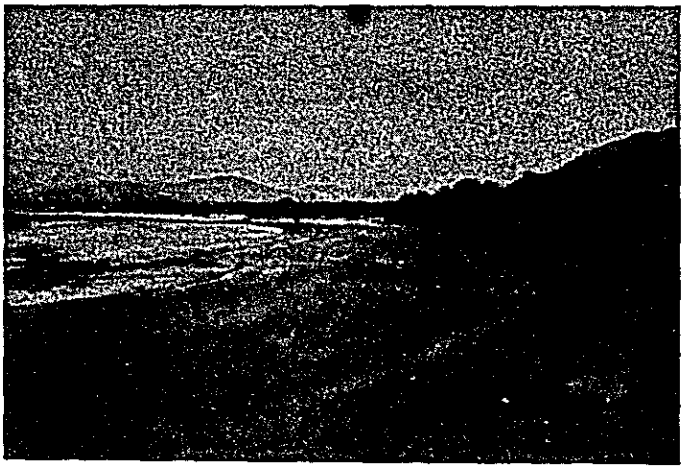
The river water is clear and has not yet been contaminated.

The drainage are is about 620 km^2 and the minimum discharge, according to the record for an 8-year period from 1957 to 1964, was 6.50 m^3/s and 7.70 m^3/s recorded in 1960 and 1964 respectively. The dry season lasts from December to May. According to the discharge graph for the 1960 — 1964 period (See attached graph), there was little rainfall in the dry season in 1960 and the river water continued to decrease since February when there was the last rainfal until it reached the minimum level in March and April. The minimum discharge of 6.50 m^3/s recorded is thought to be spring water from a good aquifer in the mountain region on upstream. It is evidenced by a report that good well water is available in abundance in the area up the river in the vicinity of the sugar mill. This will become more clear if a comparison is made between the record of precipitation and that of the river discharge.

Carebi Sugar Mill located 2 km up from the estuary gets water from this river by way of an open canal of 300 m in length and then by pumping. Besides, the mill uses groundwater which is more or less spring water available abundantly.

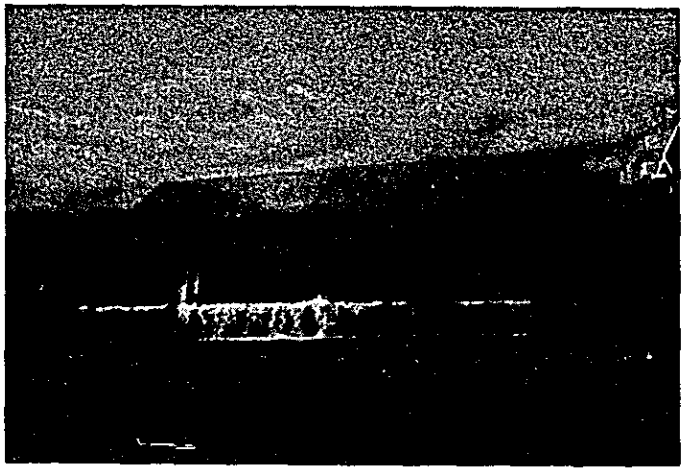
The Port of Masinloc situated 40 km north of the sugar mill is available for shipping and fuel storage.

It is recommended that a detailed survey be made on this site as a promising area for future development and that efforts be made to collect as much statistical data as possible.



A View of Upstream from the Bridge

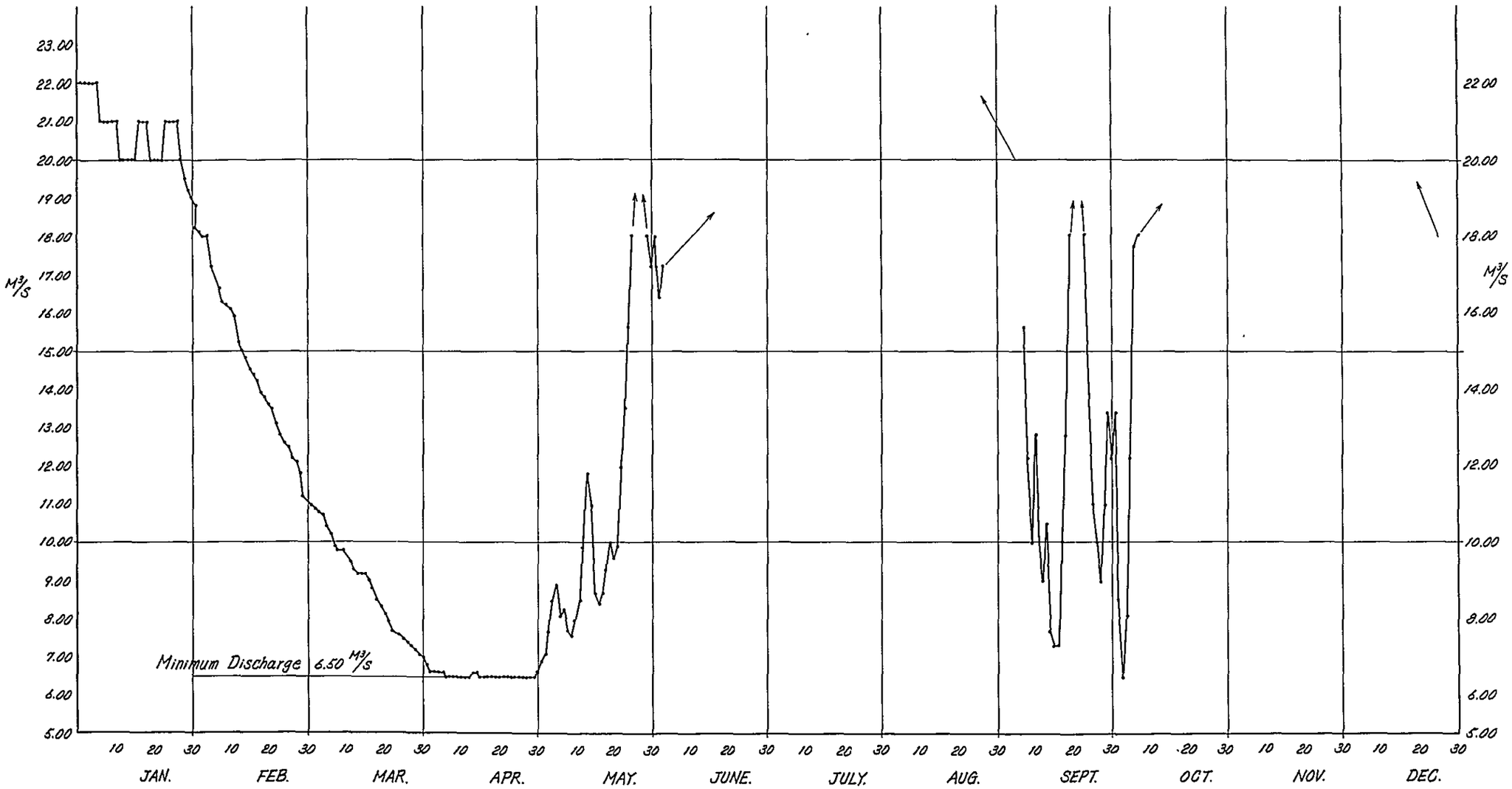
Driving Channel from the River to the Sugar Mill



Waste Water Treatment by means of Aeration at the Sugar Mill

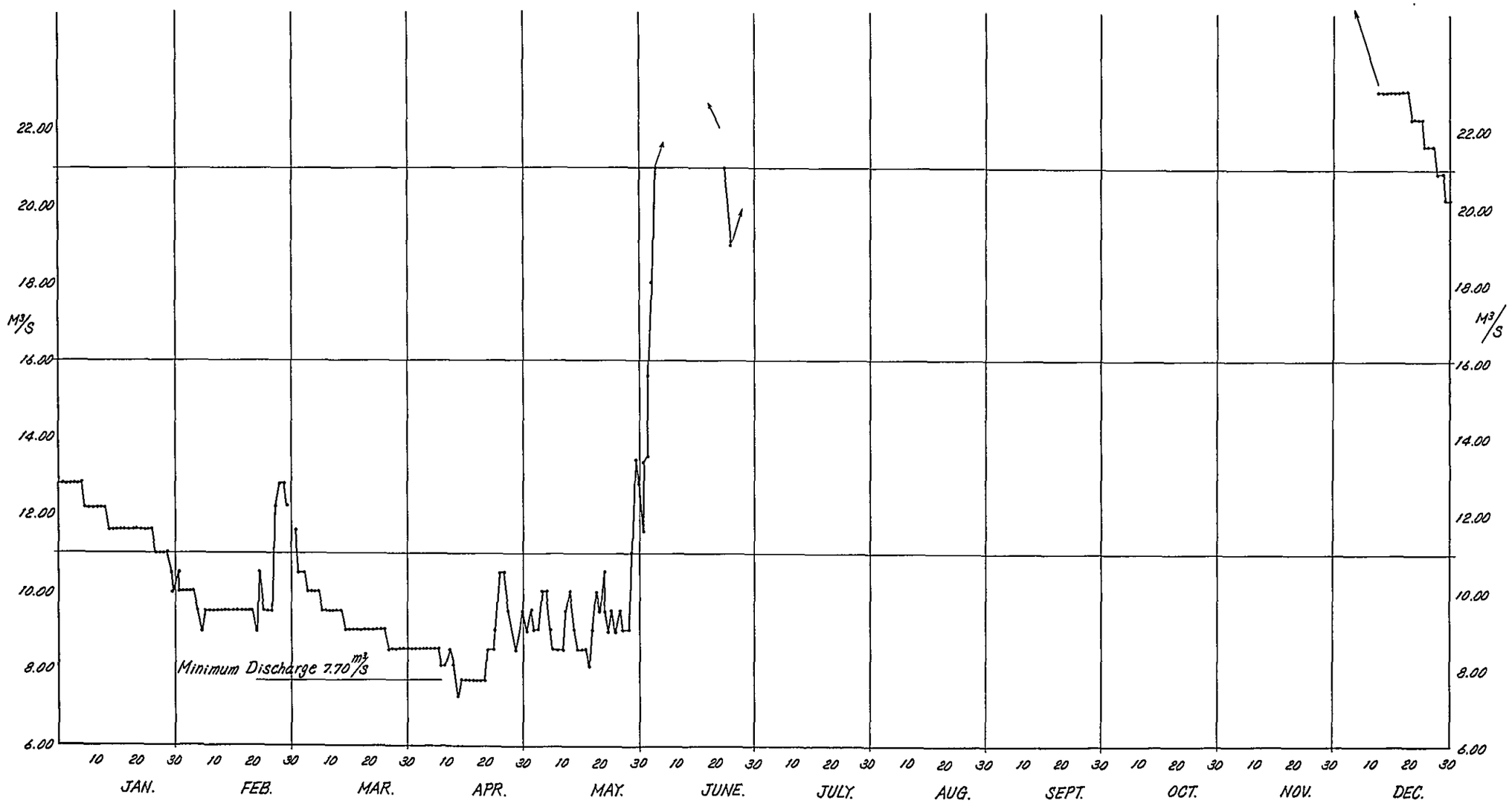
Graph 1 Discharge of the Bucao River, 1964

The Point Surveyed : 15° 16' 40" N, 120° 05' 10" E
Basin : 615 km²



Graph 2. Discharge of the Bucao River, 1960

The Point Surveyed : 15° 16' 40" N, 120° 05' 10" E
Basin : 615 km²



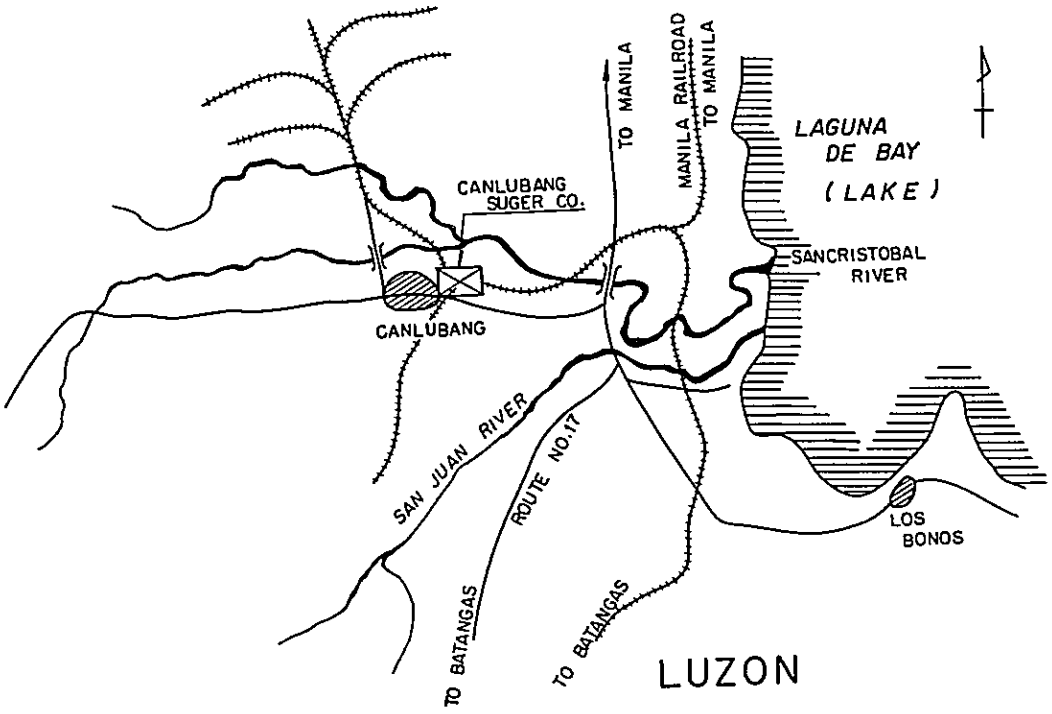
Monthly Run-Off 1957 ~ 1964, Bucao River

LUZON M³/S

	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1957	586	417	400	358	319	2317	3298	5695	3986	2773	1024	752	MAY 9.18
1958	583	417	447	332	311	3964	6245	2909	7597	2231	1058	691	MAY 918
1959	517	363	332	275	311	329	594	3611	3380	993	597	457	APR 8.50
○1960	364	291	289	255	298	1633	1380	11000	2667	3800	1023	723	APR 7.70
1961	540	382	372	300	1073	2843	5220	3974	5613	2236	1070	754	MAY 900
1962	595	465	467	438	371	457	8847	4731	3888	1587	805	609	MAY10.76
1963	471	375	384	339	418	5031	3672	3621	5422	2397	2799	734	MAY1050
○1964	639	429	373	196	366	912	1276	4165	461	1587	934	1315	APR 6.50

(2) San Cristobal River

Fig. 6



This is a small river running through Canlubang City 54 km south of Manila, Luzon Island, and flowing into Laguna de Bay.

The Canlubang Sugar Mill located upstream of the river uses good spring water and well water available in aboundance in the vicinity of the mill instead of taking water from this river. The waste water from the mill is discharged into the river which flows into Laguna de Bay.

Although no recording of river discharge is being kept, nor the data on the spring water is available, the ground water is highly promising.

The plan for construction of a pulp mill which will use bagasse from the sugar mill has been given a series of study in the past. However, the plan has made little progress due to the two reasons. First, the large amount of plant waste water from such mass water consuming industry as pulp plant is to be discharged into the Laguna Lake -- actually, it is called Laguna de Bay since it is open to the Manila Bay and is under influence of tidal range --, which causes the pollution problem because of the stagnant flow of lake water. Secondly, there is a shortage of process water. It was felt that any future plan will inevitably face this problem.

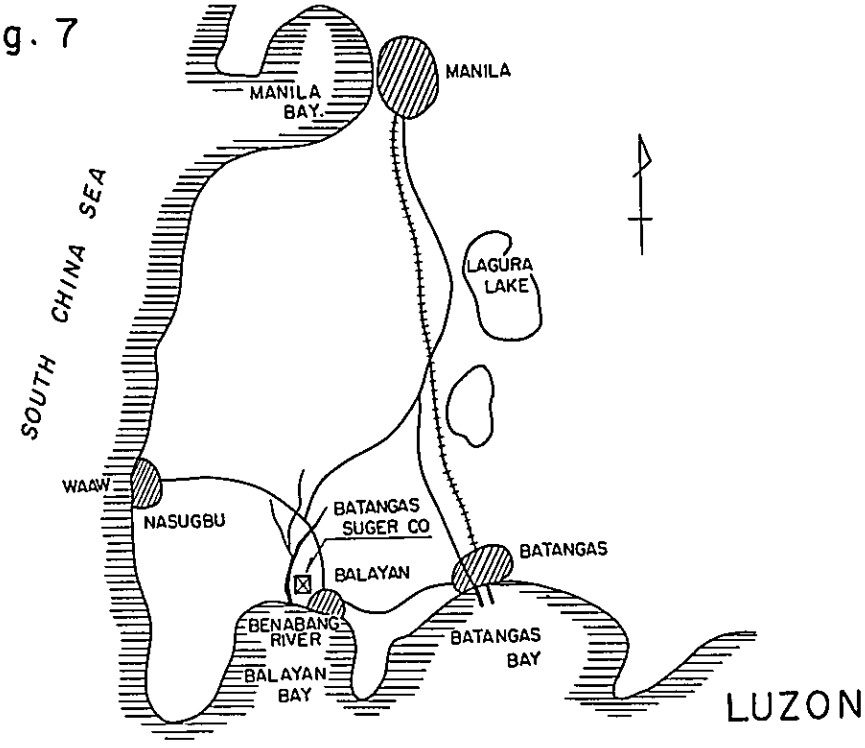
As for the condition of industrial location other than above described problems, the area is very favorably situated being very close to Manila.

It will be necessary to make an intensive detailed survey on this area in the future.

San Cristobal River

(3) Benabang River

Fig. 7



This is a small river in Luzon Island flowing through Balayan City, 130 km south of Manila and discharging into Blayan Bay. The Batangas Sugar Mill located 5 km up the estuary takes water from this river. No hydrometry is being conducted on this river. The river appears to lack discharge sufficient for use by other industries.

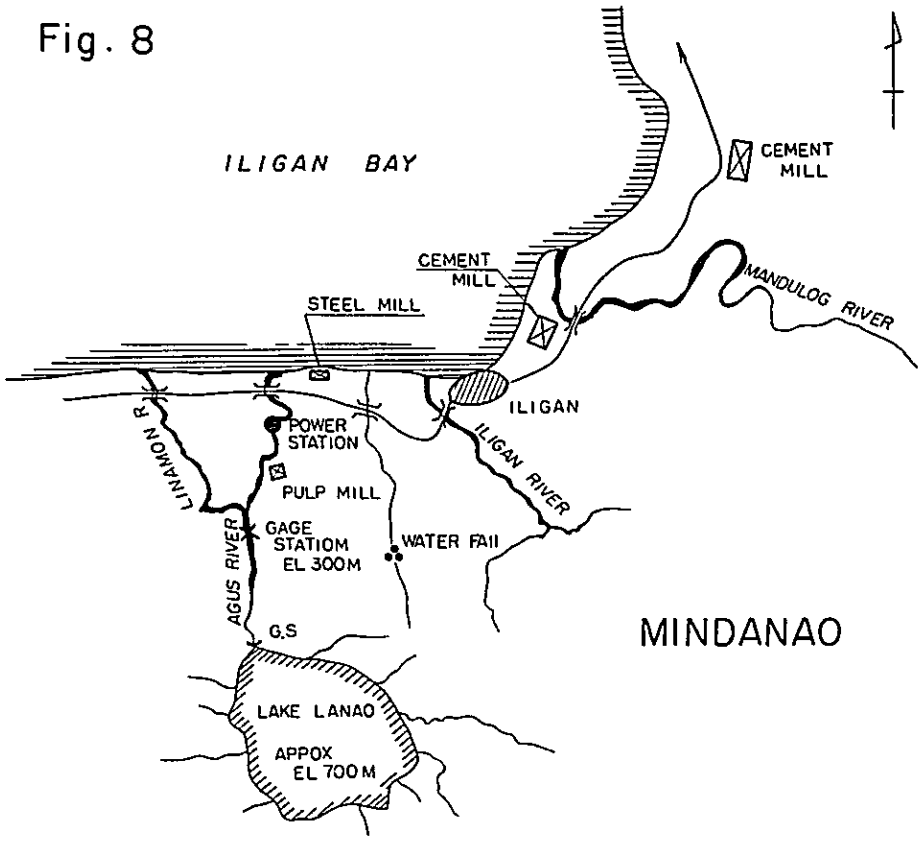
The port of Wawa in Nasugbu City is 25 km north of the sugar mill and is being used for shipment of products which are transported to the port by truck.

For the above reason, the area is not considered appropriate for the plant site of a pulp mill.

Benadang River

(4) Agus River

Fig. 8

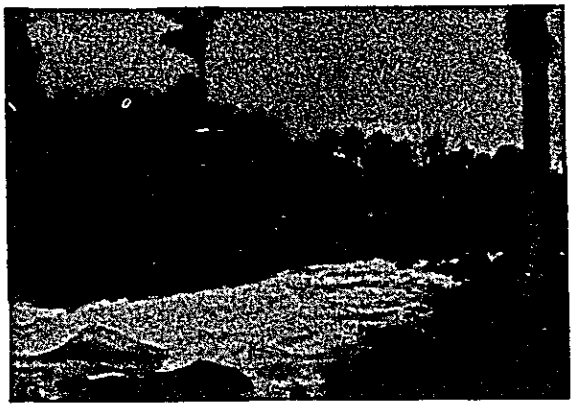


The Agus River running through the Iligan industrial area in the northern Mindanao and flowing into Iligan Bay is the only river which discharges water of Lake Lanao (E. L. 700 m). While the record of water level at the inlet of the river is available, there is no record on the discharge at this point.

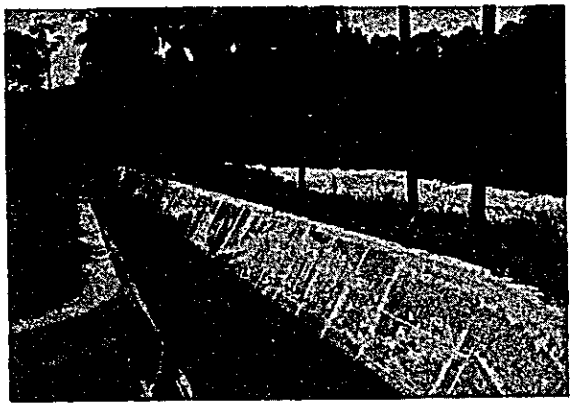
According to the discharge diagram for this river published by the government, this is a water rich river with a basin area of 2,150 km^2 at the measure point 300 m. above sea level and with the minimum discharge of 46.50 m^3/s, the maximum of 450 m^3/s and the average of 125 m^3/s.

The river has a sharp slope and is rich in rocks and gravels of large size. The water flows at a gradient of 1/100 to 1/200 and there is a 100 m high waterfall at the point 200 m above sea level (1.5 km from the coast). At this point there is a hydro power plant (150,000 KW) which supplies low priced power to the Iligan industrial area. In the industrial area there are a pulp and paper mill using lauan as raw material, a chemical plant, an iron works and a cement mill.

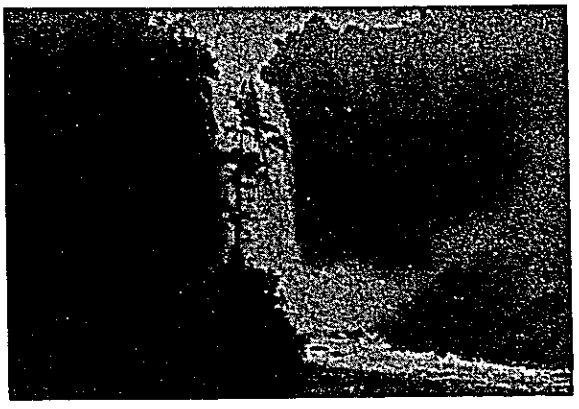
Because of the rich water resources both in river water and groundwater and the availability of good transportation both on land and sea, this area is expected to grow further in manufacturing and other industries. As for bagasse pulp industry, the area is not suitable for lack of bagasse supply.



Agus River



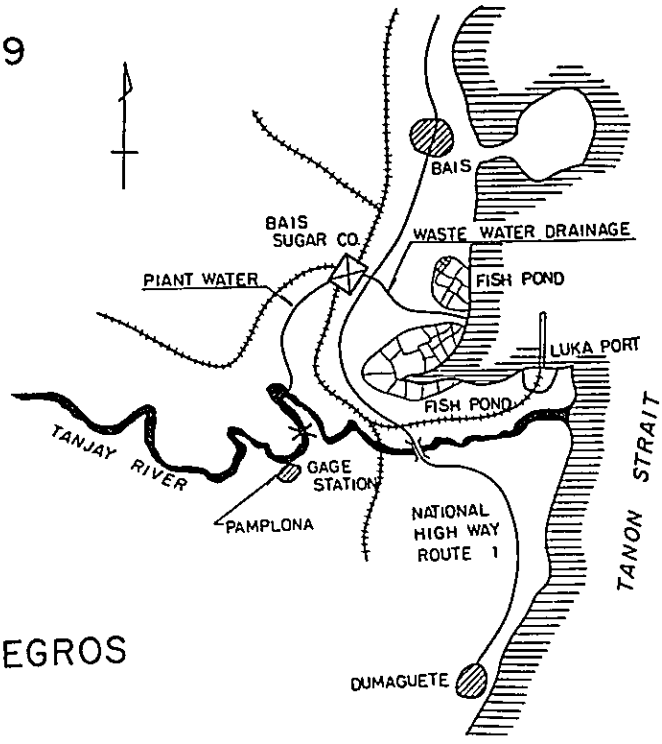
Intake of Rustan Pulp & Paper Mill



Maria Christina Fall

(5) Tanjay River

Fig. 9



This river runs 35 km north of Dumaguete City in the southeastern Negros, where National Highway Route 1 running north from the city along the coast crosses, and flows into the Tanon Strait.

The Bais Sugar Mill draws water from this river by means of a driving channel of 1,000 m in length. The minimum discharge of 2 m^3/s and 1.60 m^3/s were recorded at Pamplona gage station in 1966 and 1967 respectively.

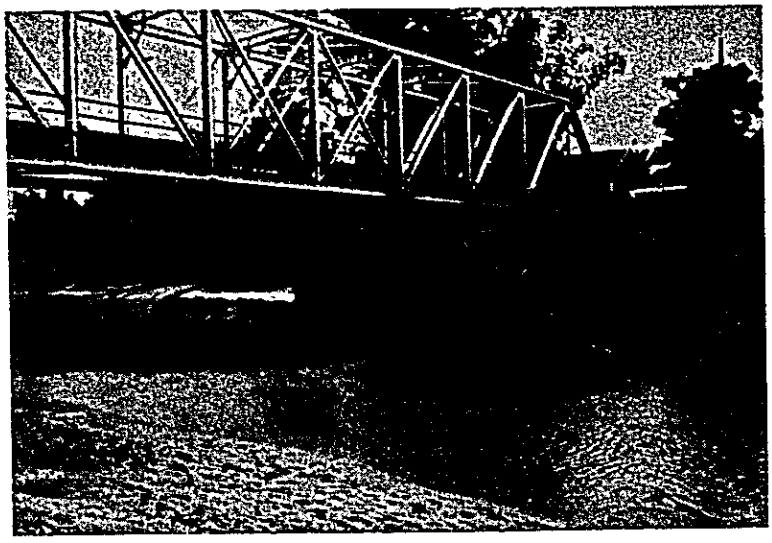
According to the record for a 9-year period from 1959 to 1967, the dry season in this region is from March through June. In addition to sugar production, the Bais Sugar Mill also produces bagasse pulp at the rate of 35 T/D.

Because of the soda process employed in pulp production, the waste water from the pulp plant is brown in color, which is discharged directly into a creek extending to the coast without being treated. It may have some effect on the fish ponds, but there seems to be no serious problems at the present stage.

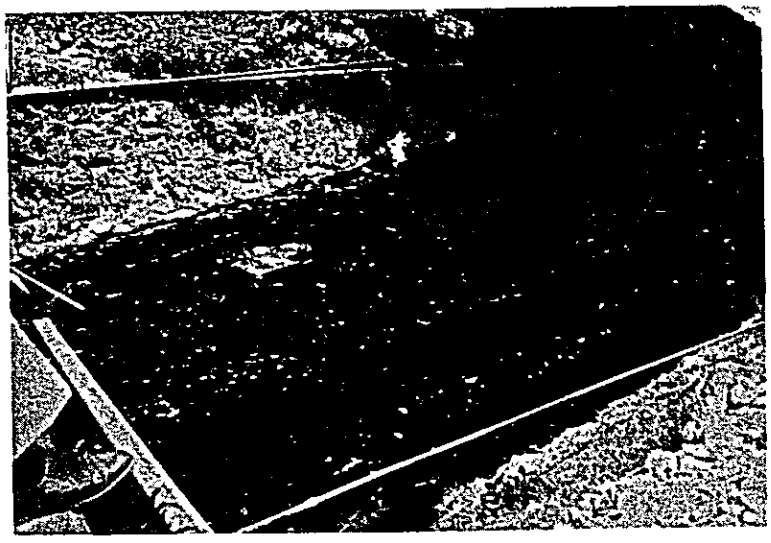
Although both the river water and groundwater are being used for plant water, the discharge of the river has very little room for further uses when the expansion of the existing sugar mill is taken into consideration.

For shipment, the products are transported by railroad to Luka Port, an exclusive port of the mill. This area is not considered appropriate for an industrial plant.

Tanjay River

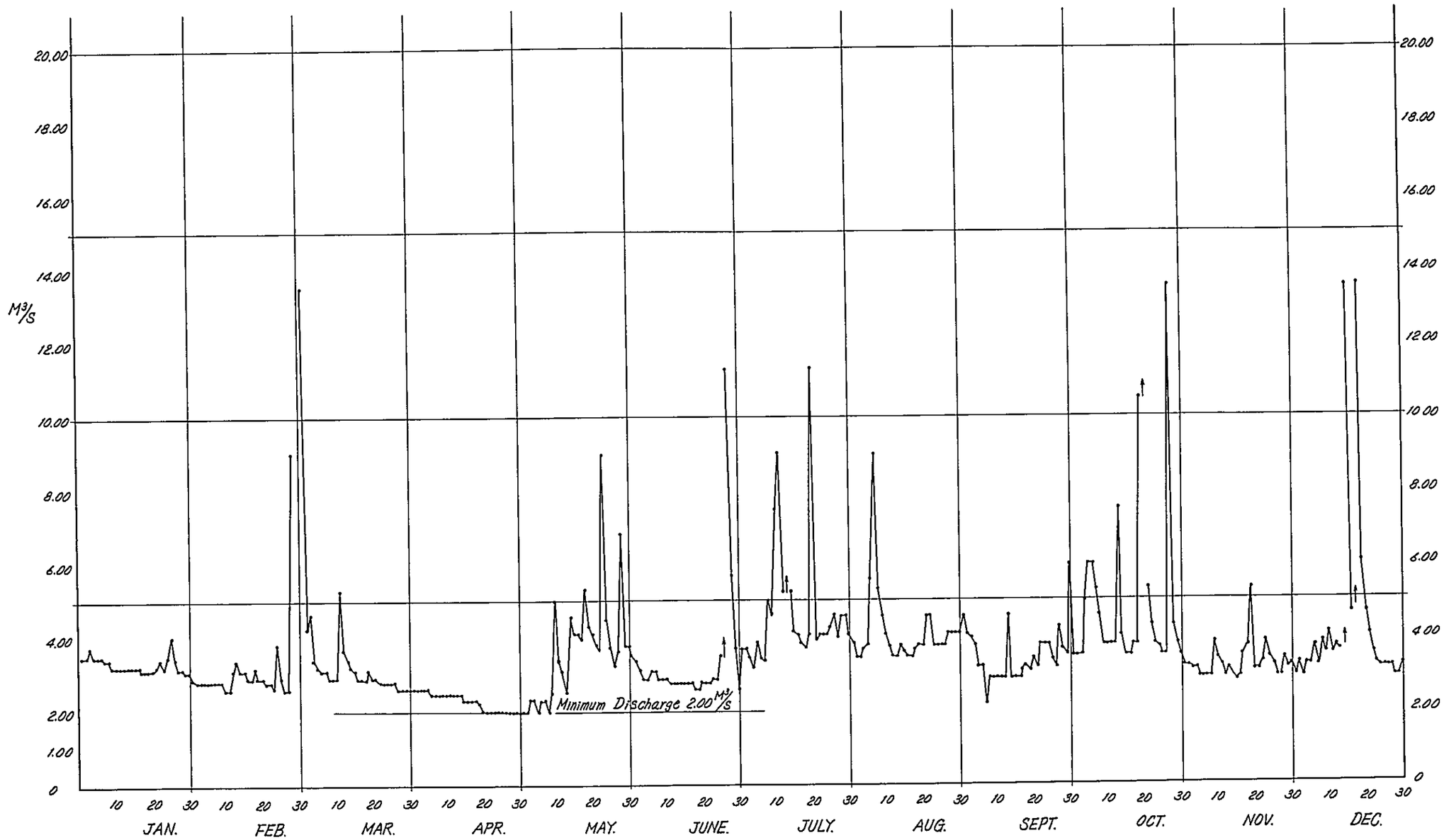


Waste Water Drainage of Bais Sugar Mill



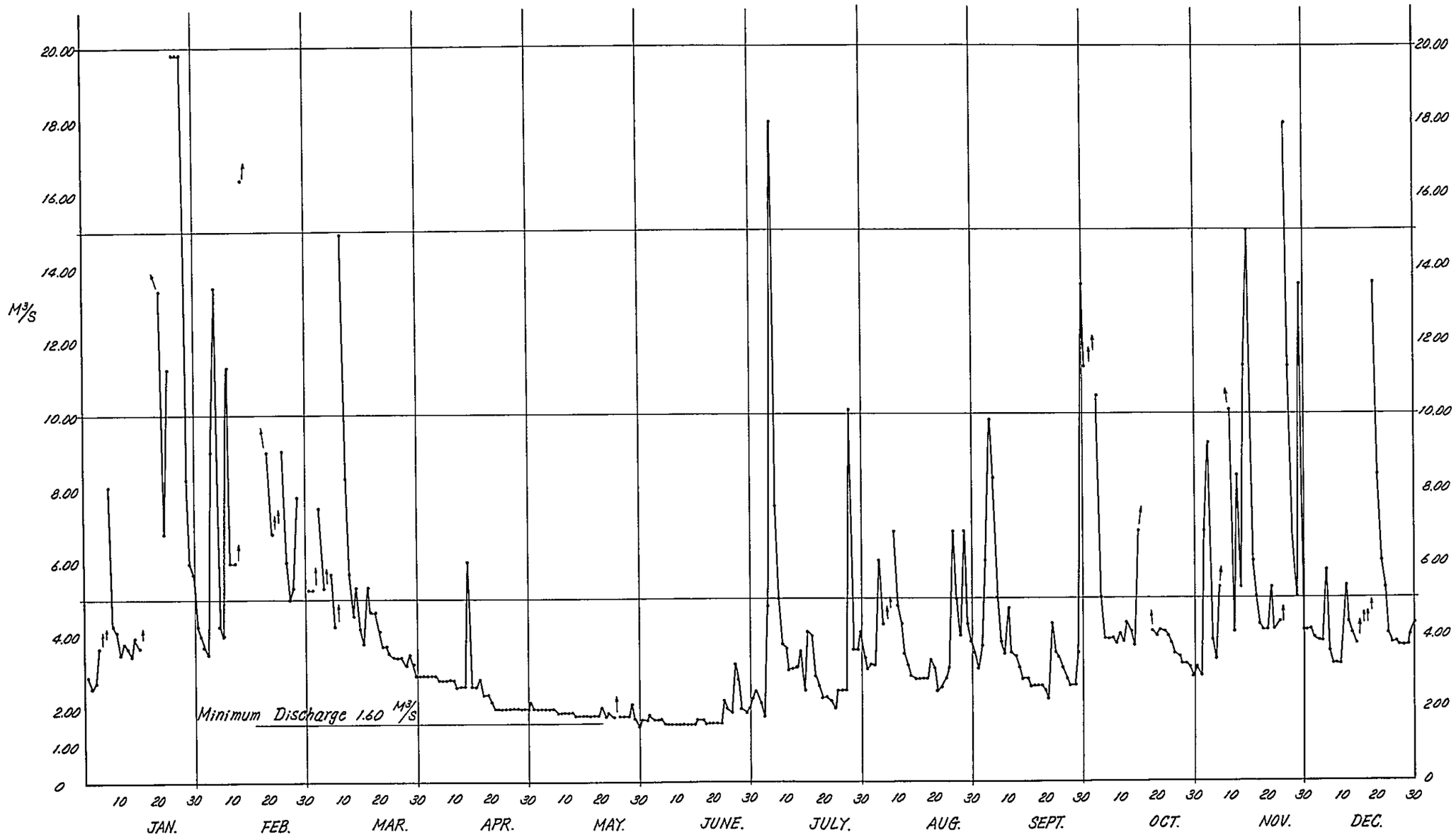
Graph 3. Discharge of the Tanjay River, 1966

The Point Surveyed : 9° 27' 55" N, 123° 06' 27" E
Basin : 138 km²



Graph 4. Discharge of the Tanjay River, 1967

The Point Surveyed : 9° 27' 55" N, 123° 06' 27" E
Basin : 138 km²



Monthly Run-Off 1959 ~ 1967, Tanjay River

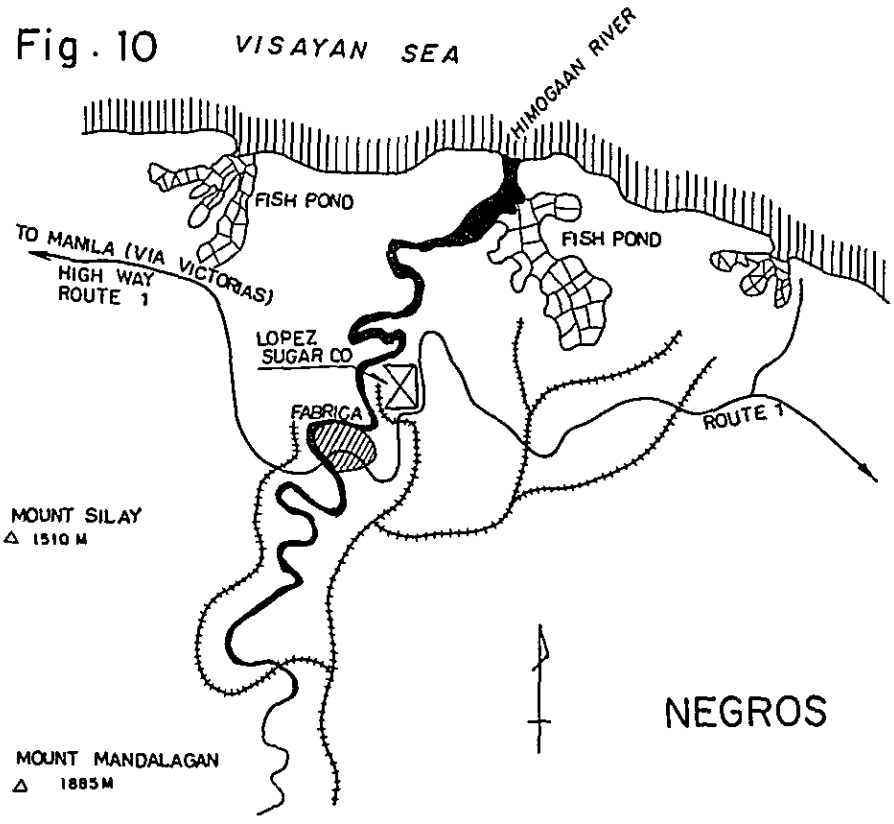
NEGROS

M³/S

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1957													
1958													
1959	465	168	442	196	142	164	467	334	201	591	405	561	JUNE3.30
1960	647	587	280	116	125	146	165	154	189	832	486	419	MAY 350
1961	1378	449	178	128	124	255	325	450	178	296	246	457	MAY 3.50
1962	321	1344	1084	119	121	286	1072	373	985	285	464	649	JUNE350
1963	1564	624	475	109	118	172	163	180	539	451	394	420	APR 320
1964	306	-	-	-	175	167	245	173	143	145	727	830	-
1965	1388	783	666	251	183	311	1524	437	412	224	155	248	MOV 3.65
○1966	101	86	107	68	113	123	194	131	104	163	96	247	APR 2.00
○1967	825	900	298	77	61	54	202	160	121	416	478	424	JUNE1.60

(6) Himogaan River

Fig. 10

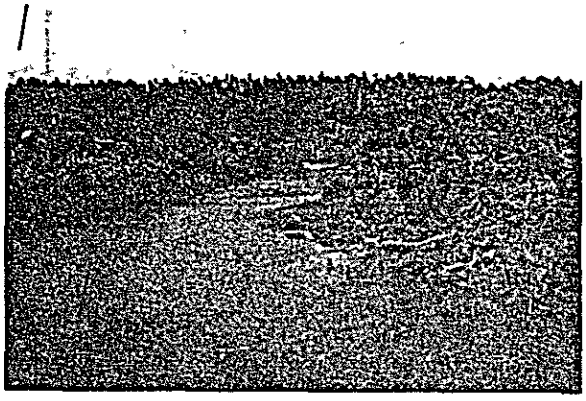


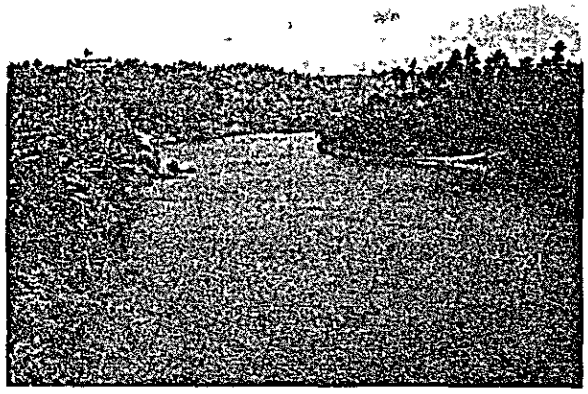
This river originating in Mt. Silay and Mt. Mandalagan flows through the town of Fabrica and discharges into Visayan Sea at the north tip of Negros Island. The Lopez Sugar Mill located 8 km up the estuary takes water from this river. One of the disadvantages of the sugar mill is that the sugar products loaded on barges at the pier in the compounds have to be reloaded on to large vessels anchored off-shore.

As no hydrometry is conducted, there is no data on the river discharge available. From the estimated specific discharge on the assumption that this river is under the same condition as the neighboring Malogo River, the discharge is considered sufficient.

The basin of the river is 150 km^2. As there is a large timber mill across the river, it will be necessary to make a detailed survey of the area as a prospective supply source of timber and non-timber materials.

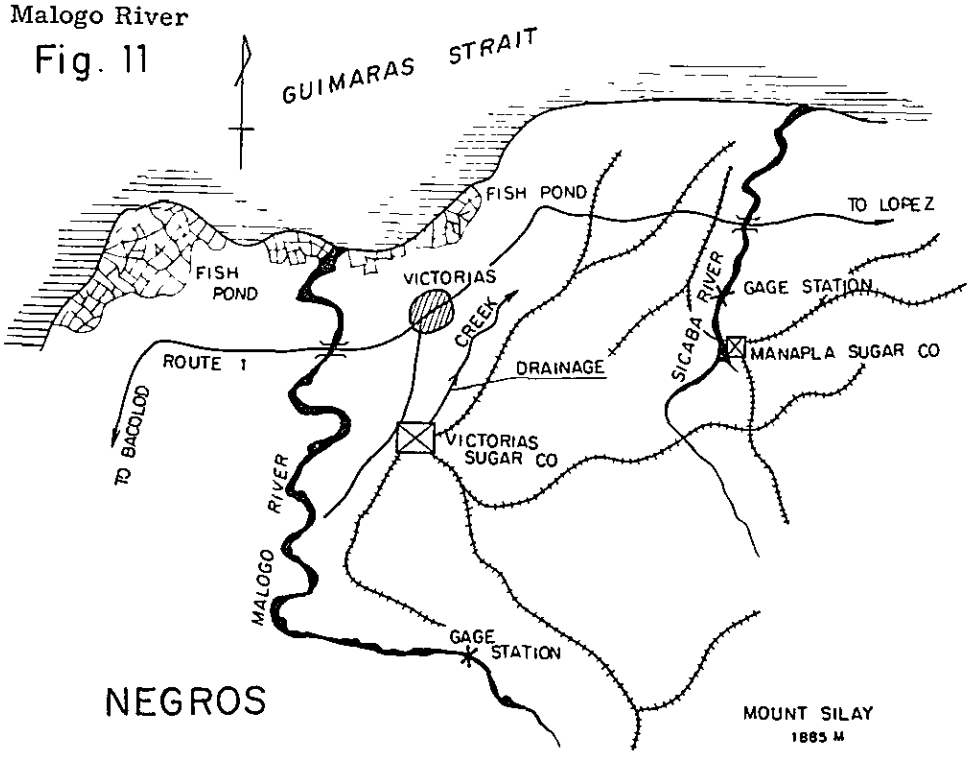
Himogaan River





(7) Malogo River

Fig. 11



This is a large river originating in Mt. Silay and flowing into the Guimaras Strait at the northwestern tip of Negros Island. The Victorias Sugar Mill located about 7 km up the estuary takes water from this river.

According to the record for a 10-year period from 1960 to 1969, the minimum discharges were recorded in 1964 and 1968. The minimum discharge in 1964 was 0.9 m^3/s recorded on September 21 and the discharge less than 3 m^3/s was recorded in 8 days. On the day before this low discharge there was a sudden decrease in the discharge from 35.5 m^3/s $\rightarrow$ 14 $m^3/s \rightarrow$ 6.4 $m^3/s \rightarrow$ 2.2 m^3/s. For this phenomenon, three factors, -- dry season, use of river water for other purposes and errors in measurement -- are conceivable. If this phenomenon is seen in March or April, it should be regarded as the minimum discharge.

But it is the phenomenon which should not be taken up in the case of Malogo River. Consequently, 3 m^3/s is to be used as the minimum discharge (record of 10 years) of this river. As there are many rivers originating in Mt. Silay (1,885 m above sea level) in the neighboring area and such small rivers as the Cicaba River (water from which is used by the Manapla Sugar Mill) are available, there is no apprehension as to the quantity of water available.

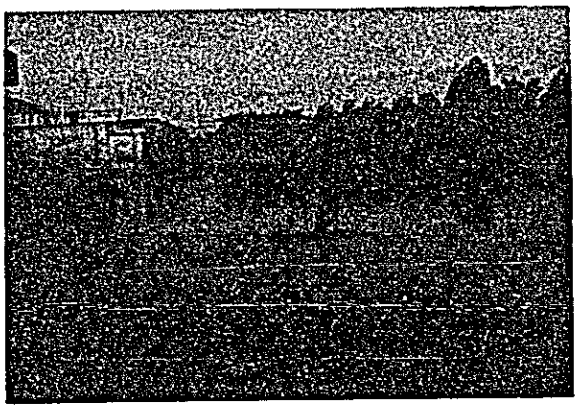
As for the rainfall, the Victorias Sugar Mill keeps a record of precipitation for the period from 1947 to 1970. According to this record, there are 9 rainy days in the month of April, which means that there is rainfall every three days, with the record of precipitation being 3.4 inch. The annual minimum rainfall was 1,380 mm which was recorded in 1968.

Judging from the above, the discharge of rivers in this area is considered sufficient for the project.

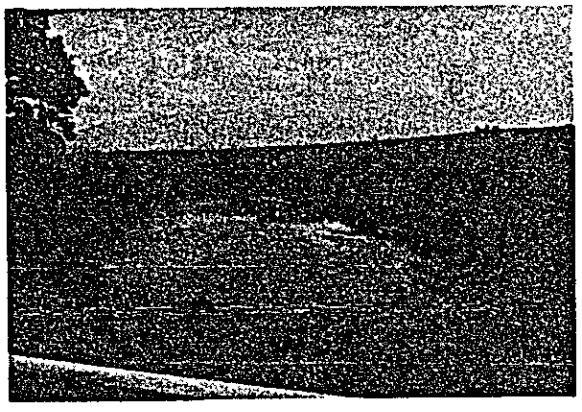
As for the port and harbours, there is no port available and all shipment are made by small barges (Approximately 500 tons in loading capacity) through nearby creeks to ocean-going vessels anchored off-shore for reloading. This is one of the greatest disadvantages of this area.

As the area is under favorable conditions for construction of a sugar mill and other types of industry, it will be necessary to plan construction of a port in this area.

Malogo River



Sicaba River

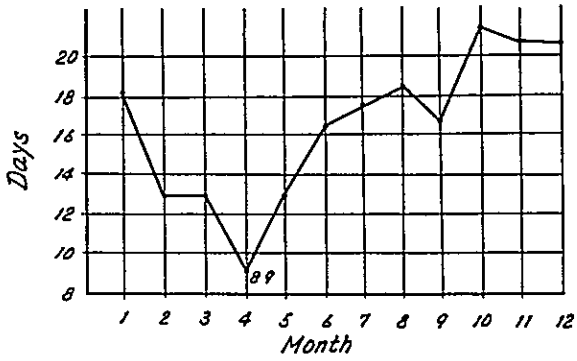


Monthly Run-Off 1960 ~ 1969, Malogo River

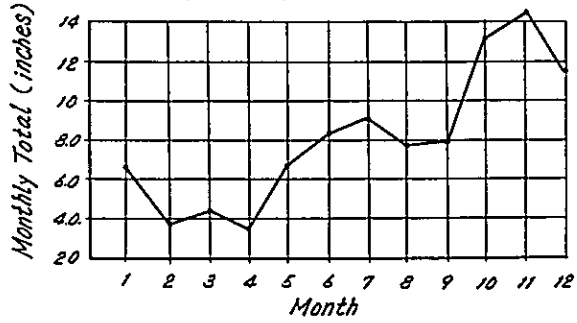
NEGROS M³/S

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1960	-	-	319	-	-	-	-	613	-	-	2093	986	
1961	1880	841	360	232	287	639	719	844	310	604	-	-	APR 5.80
1962	572	1990	608	191	235	346	903	947	854	384	-	-	MAY 4.60
1963	-	991	1055	271	201	273	244	-	-	-	-	816	MAY 5.80
○1964	330	1519	317	301	216	443	455	500	251	347	1664	379	SEPT 2.00
1965	708	575	698	261	247	412	486	427	303	453	324	785	SEPT 5.60
1966	305	216	193	150	1093	231	375	283	278	569	364	588	APR 4.70
1967	1478	1484	777	396	265	346	489	310	233	344	727	600	SEPT JUNE 6.40
○1968	819	315	197	144	138	161	404	872	348	313	1253	567	MAY 3.80
1969	407	228	191	166	200	233	371	320	354	273	298	851	MAY 4.80

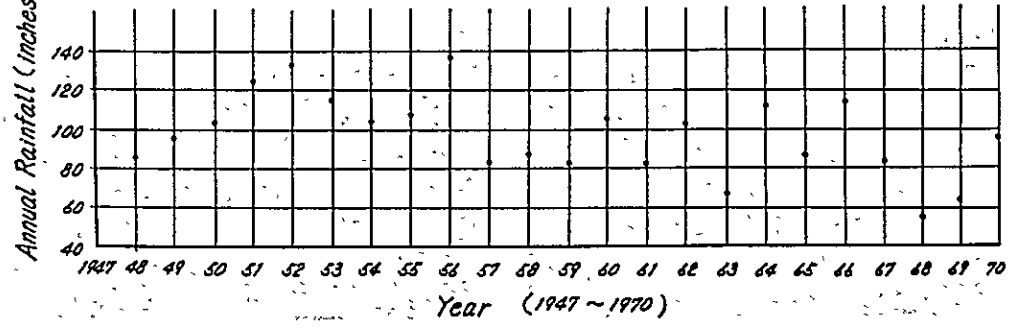
Graph 5. Monthly Rainfall in the Past 24 Years (Average)



Monthly Average of Rainfall (in the Past 24 Years)

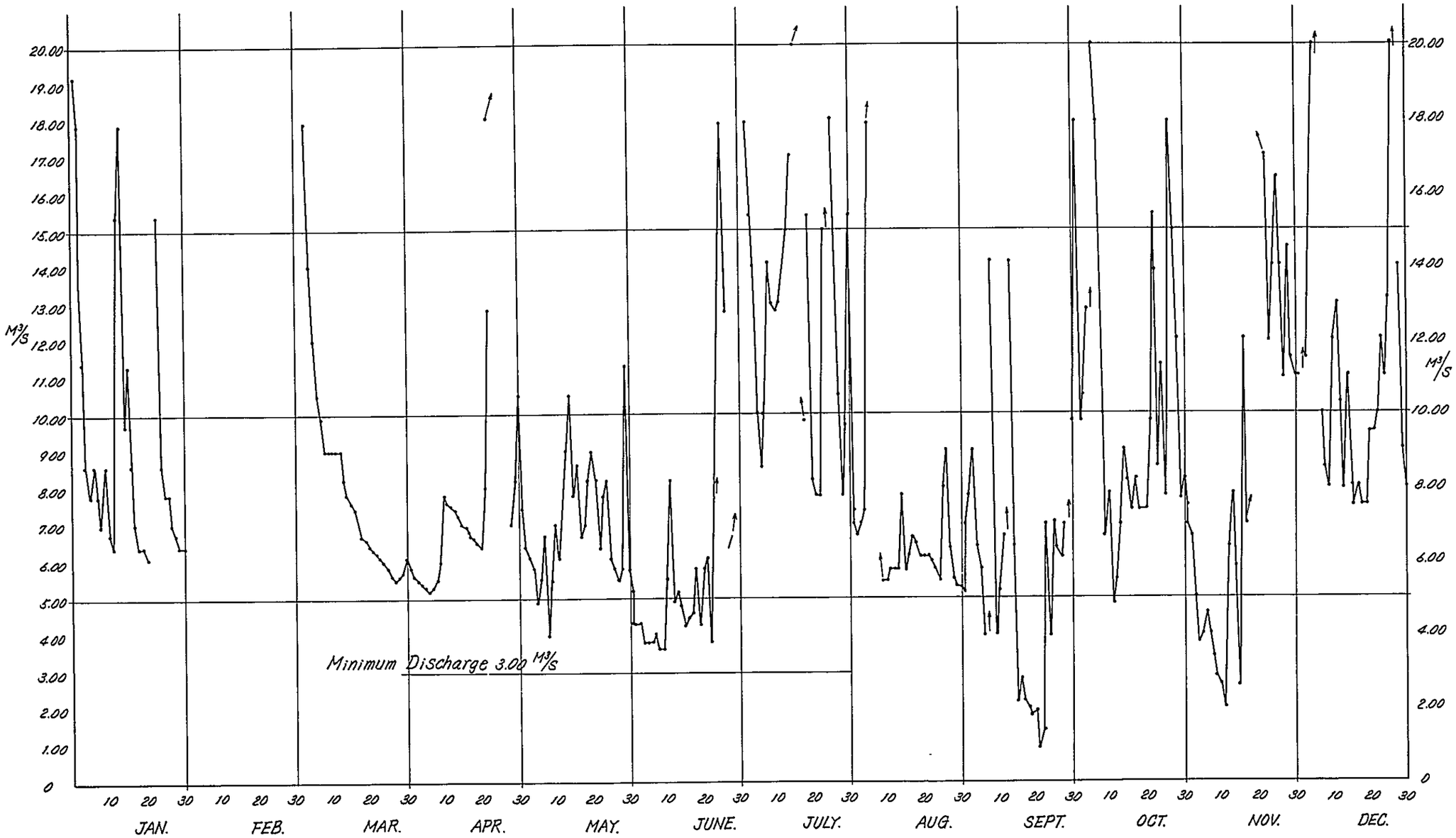


Annual Rainfall, 1947~1970 (mm)



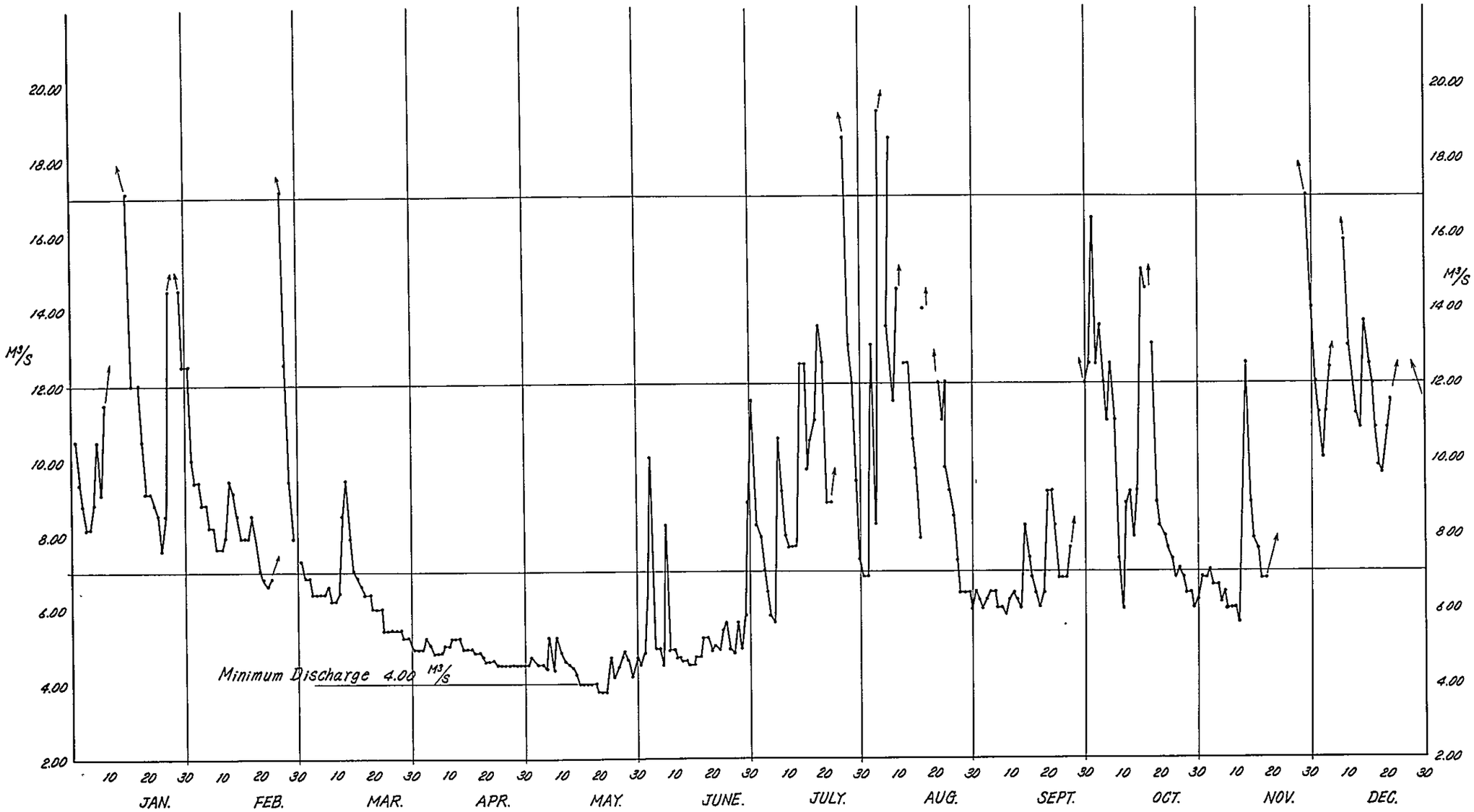
Graph 6. Discharge of the Malogo River, 1964

The Point Surveyed : 10° 49' 03"N, 123° 04,52"E
Basin : 129 km²



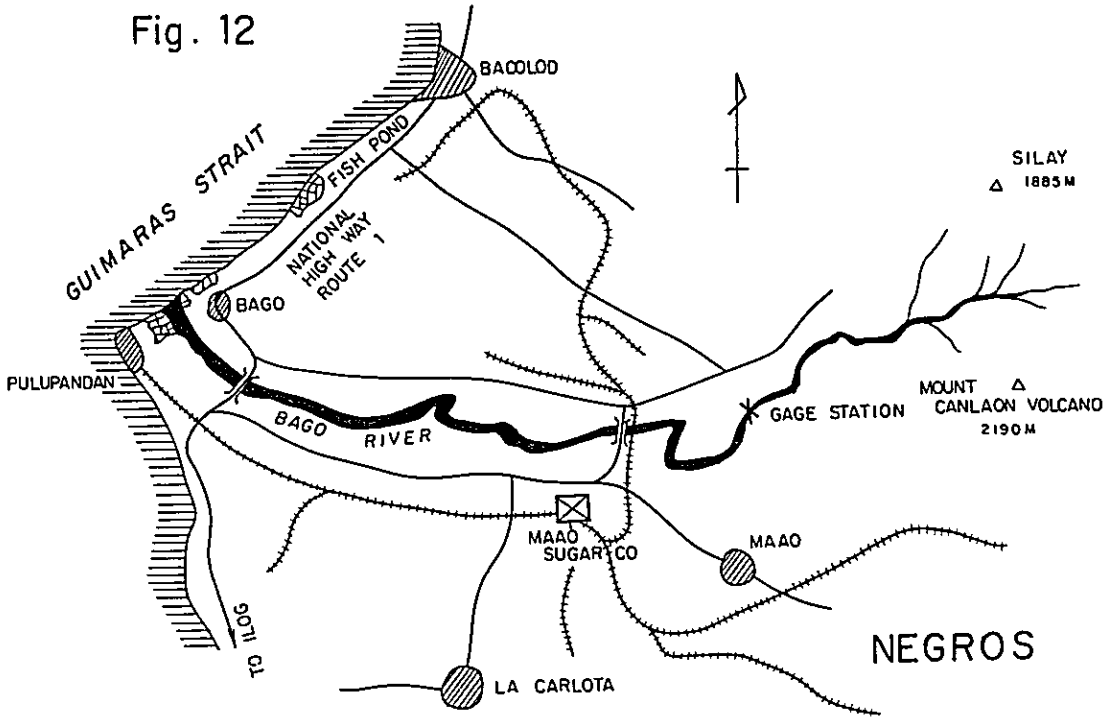
Graph 7. Discharge of the Malogo River, 1968

The Point Surveyed : 10° 49' 03" N, 123° 04' 52" E
Basin : 129 km²



(8) Bago River

Fig. 12



The Bago River located approximately 20 km south of Bacolod City, Negros Island, originates in the south side of Mt. Silay and the north side of Mt. Canlaon, runs down through valleys and flows into the Guimaras Strait. At the point 18 km up the estuary there is the Ma-ao Sugar Mill which takes water from the river.

The basin of this river measured at the gage station 10 km up Maoa City is 683 km^2. According to the record of discharge for a 14-year period from 1956 to 1969, the minimum discharge was 9.6 m^3/s in 1957 and 4 m^3/s in 1969 and the discharge of more than 10 m^3/s was recorded for other years.

If an intake was provided at the site of Bago Sugar Mill, the basin would increase and the discharge would also increase from the present level of 4 m^3/s accordingly. Therefore, the discharge at that point is sufficient for the current project.

As for the rainfall, a record of precipitation, is being kept by a near-by sugar mill as will be shown on the subsequent page. According to the record, there is rainfall every two days and the rise and fall of the water level, is in a normal pattern.

Therefore, no serious problems are apprehended even in the dry season. The meteorology of the rivers which will be mentioned in the subsequent sections (9), (10) and (11) are considered to be similar to this. The discharge, therefore, is considered sufficient for the future project.

As for the port and harbour, the port of Pulupandan situated 2 km north of the estuary is a good port with a railroad line laid from a sugar mill and equipped with oil storage facilities and good quay walls (See photos).

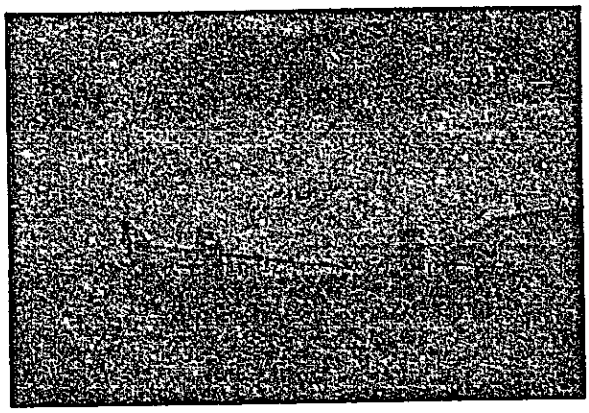
The raw material bagasse is being stored at a large storage yard in the vicinity of the port and a storage yard located 10 km south of the port, which is owned by the La Carlota Sugar Mill.

Although there are some fish ponds near the estuary, no serious problems of effluent water are seen. The proposed site satisfies all requirements for plant location and is therefore considered suitable for construction of a pulp and paper plant. Efforts should be made in the future to conduct more detailed surveys and obtain statistical data on an intensified scale.

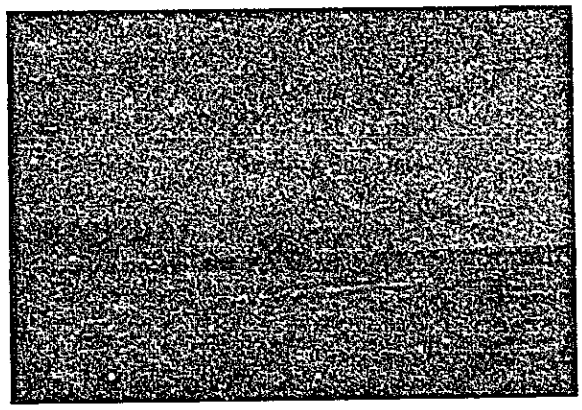
Monthly Run-Off 1956 ~ 1969, Bago River

NEGROS M³/S

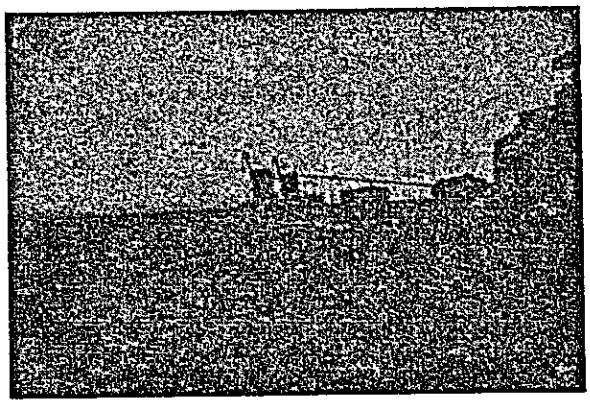
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1956	1562	556	639	1728	1579	1172	2169	2133	2312	1686	1321	3283	1111
○1957	2116	990	631	121	101	175	1098	1718	1710	1148	611	472	960
1958	485	109	116	130	175	-	865	572	1108	1696	1395	919	1190
1959	681	111	510	159	539	-	1696	1895	1409	1371	1253	1042	1302
1960													
1961													
1962													
1963													
1964													
1965	-	790	853	567	146	1111	2032	1772	1805	2013	815	1065	MAY 1226
1966	477	386	395	-	2362	-	1785	4409	1131	1353	766	732	MAR 1021
1967													
1968													
○1969	-	-	232	650	-	819	2475	1187	2025	1016	375	439	MAY 400



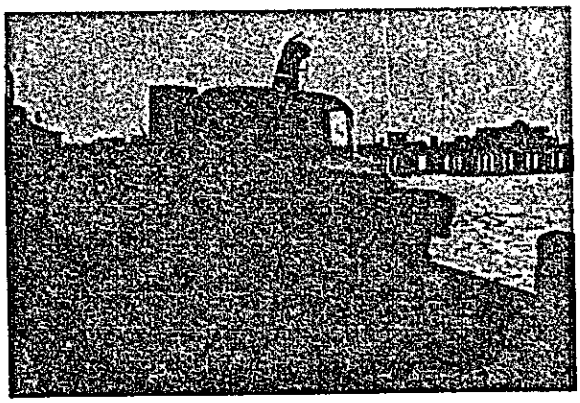
Pulpandan Port



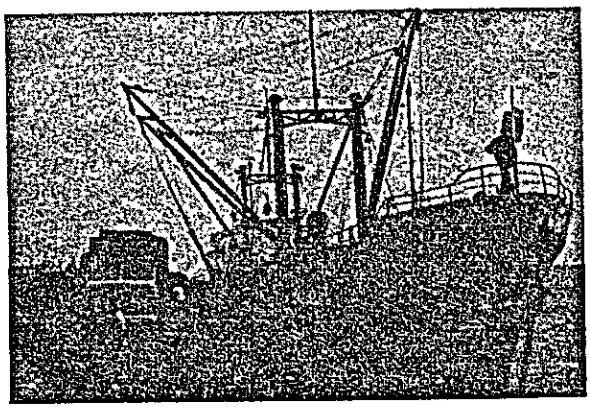
Pier for Sugar



Pier for General Cargo



Pier



Pier

Negros Occidental
Province

Station: Calapnagan, La Castellana (Canlaon Ref/Project)
Ordinary Climatological Station
10° 21' North; 123° 01' East

Jose L. Lechoncito
Observer

Month 1964	RAINFALL (mm.)										
	Total	Greatest in One Day	Date	0.1 or more	1.0 or more	10.0 or more	25.0 or more	50.0 or more	100.0 or more	Normal (13-Yrs) Amount	Normal (13-Yrs) Rainy Days
Jan.	4.3	1.8	21	5	2	0	0	0	0	63.8	4
Feb.	52.8	47.0	15	8	4	1	1	0	0	28.7	3
Mar.	1.5	1.5	19	1	1	0	0	0	0	42.9	4
Apr.	49.8	21.6	29	6	5	2	0	0	0	56.6	4
May	198.4	31.8	13	14	14	7	3	0	0	190.8	10
Jun.	.	.	.	.	.	.	.	.	.	239.5	13
Jul.	221.2	82.6	5	11	9	5	3	2	0	344.4	16
Aug.	66.3	40.6	12	6	5	2	1	0	0	404.1	16
Sept.	507.5	116.8	28	20	20	11	8	4	1	488.2	19
Oct.	506.7	58.4	20+	22	22	18	9	2	0	426.7	16
Nov.	767.6	193.0	20	25	21	16	10	5	2	294.6	11
Dec.	64.0	20.3	30	11	7	3	0	0	0	222.5	7
										2,802.8	123

Note: Temperature data of this station not publishable.

Station: La Carlota, (Sugar Central)
Ordinary Climatological Station
10° 24' North; 122° 56' East

Jose Aligaen
Observer

Month 1964	RAINFALL (mm.)										
	Total	Greatest in One Day	Date	0.1 or more	1.0 or more	10.0 or more	25.0 or more	50.0 or more	100.0 or more	Normal (32-Yrs) Amount	Normal (32-Yrs) Rainy Days
Jan.	15.5	10.9	14	5	4	1	0	0	0	67.8	9
Feb.	52.6	20.3	16	8	6	3	0	0	0	55.4	7
Mar.	23.9	23.4	1	2	1	1	0	0	0	66.8	7
Apr.	255.8	98.3	16	12	11	6	5	1	0	98.6	9
May	265.4	53.9	16	18	17	9	4	1	0	253.5	17
Jun.	199.4	59.9	29	14	14	8	2	1	0	258.3	20
Jul.	61.0	18.3	5	13	13	1	0	0	0	456.2	24
Aug.	315.2	84.1	25	14	13	8	5	2	0	382.5	21
Sept.	445.0	90.7	17	16	16	11	9	2	0	385.5	21
Oct.	132.6	25.4	30	17	15	6	1	0	0	357.6	22
Nov.	506.0	254.5	19	24	22	9	5	1	1	268.5	16
Dec.	111.8	64.0	27	9	7	2	1	1	0	143.8	11
Annual	2384.2	254.5	XI-19	152	139	65	32	9	1	2804.5	184

Negros Occidental
Province

Station: La Carlota Sugar Central (La Carlota)
Ordinary Climatological Station
10° 24' North; 122° 56' East

Jose Aligaen
Observer

Month 1964	TEMPERATURE (°C)								
	Mean	Mean Maximum	Mean Minimum	Highest	Date	Lowest	Date	Number of days with 35° or Above	Number of days with 21.1° or Below
Jan.	27.0	33.2	20.7	35.4	8	16.1	18	1	19
Feb.	27.0	32.3	21.6	34.6	16	18.4	5	0	16
Mar.	27.2	34.0	20.3	35.8	31	17.5	19	7	27
Apr.	28.5	34.7	22.3	37.8	9+	19.0	6	13	8
May	28.0	32.7	23.3	34.6	6	21.1	2	0	1
Jun.	26.6	31.2	22.0	34.0	17	21.7	29	0	0
Jul.	27.4	32.0	22.7	34.4	26	21.2	7	0	0
Aug.	27.2	31.4	23.0	34.7	9	21.7	13+	0	0
Sept.	27.2	31.7	22.8	33.3	13	21.1	9	0	1
Oct.	27.3	32.1	22.5	33.8	18	21.1	16	0	1
Nov.	26.6	31.2	22.2	33.6	16	19.7	30	0	2
Dec.	26.3	31.0	21.6	34.9	9	20.3	28	0	14
Annual	27.2	32.3	22.1	37.8	IV-9+	16.1	I-18	21	89

Station: La Granja Expt. Station
Precipitation Station
10° 24' North; 122° 59' East

Santiago P. Aquino
Observer

Month 1964	RAINFALL (mm.)										
	Total	Greatest in One Day	Date	0.1 or more	1.0 or more	10.0 or more	25.0 or more	50.0 or more	100.0 or more	Normal (39-yrs) Amount	Normal (39-yrs) Rainy Days
Jan.	16.8	10.4	14	5	4	1	0	0	0	65.3	8
Feb.	80.8	30.0	14	8	7	2	1	0	0	49.3	6
Mar.	0.8	0.5	1	2	0	0	0	0	0	55.4	6
Apr.	161.3	57.2	15	8	8	5	3	1	0	96.0	8
May.	187.2	27.9	11	17	16	9	2	0	0	287.5	16
Jun.	317.5	188.0	30	16	16	7	2	1	1	309.9	20
Jul.	171.7	24.1	14	17	15	8	0	0	0	452.9	22
Aug.	327.7	114.3	25	12	12	6	4	2	1	387.4	20
Sept.	495.8	66.0	27	23	23	18	8	2	0	434.3	21
Oct.	225.0	39.1	6	17	15	9	3	0	0	391.9	21
Nov.	685.6	348.0	19	24	21	11	6	3	1	258.1	15
Dec.	82.8	20.1	17	9	9	2	0	0	0	160.5	11
Annual	2753.0	348.0	XI-19	158	146	78	29	9	3	2948.5	174

Negros Occidental
Province

Station: Maao Central, Bago
Ordinary Climatological Station
10° 29' North; 122° 57' Ewst

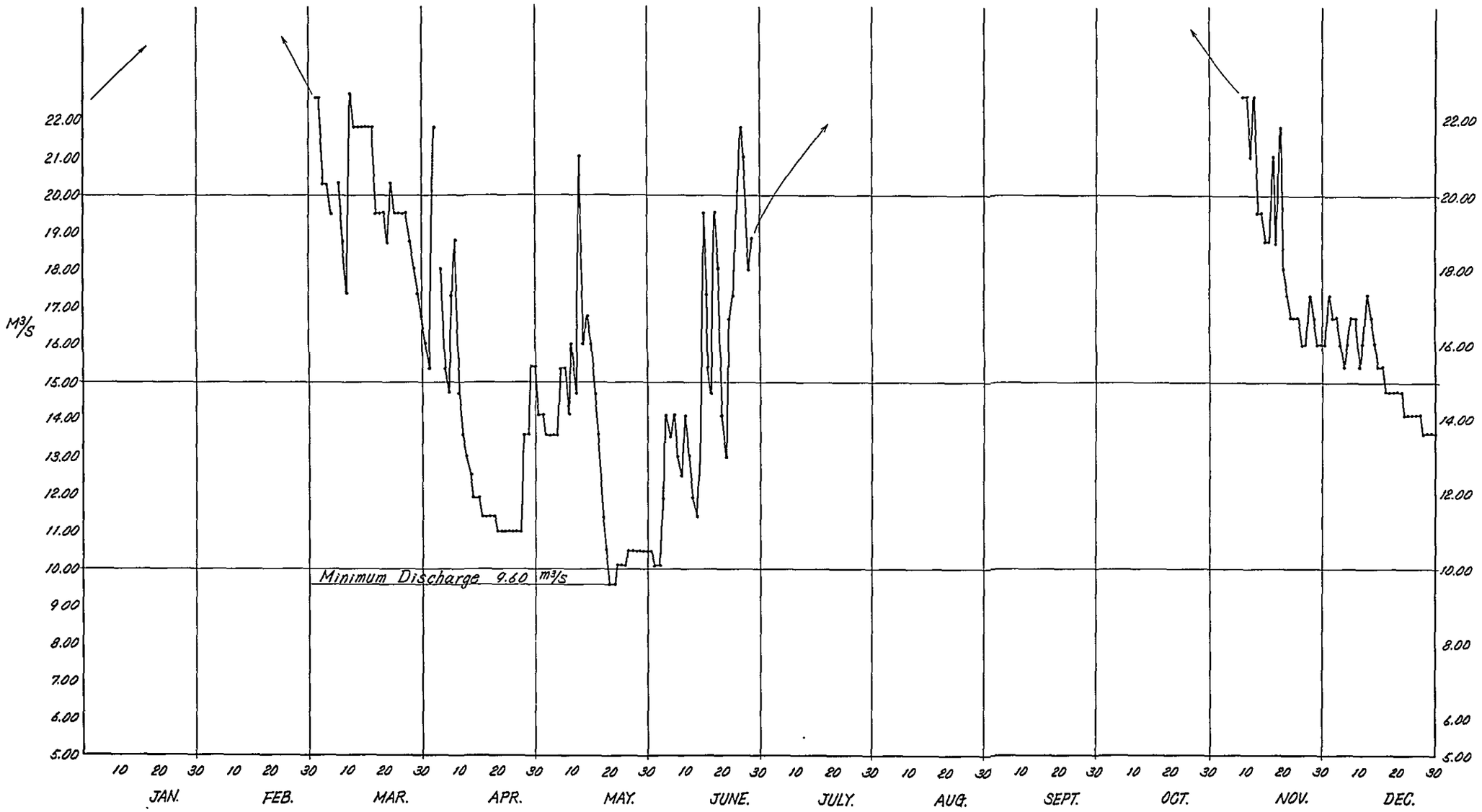
Jose Q. Jarabas
Observer

Month 1964	RAINFALL (mm.)										
	Total	Greatest in One Day	Date	0.1 or more	1.0 or more	10.0 or more	25.0 or more	50.0 or more	100.0 or more	Normal (26-yrs)	
										Amount	Rainy Days
Jan.	9.4	4.3	14	4	2	0	0	0	0	120.4	7
Feb.	42.4	30.2	14	5	5	1	1	0	0	44.5	6
Mar.	8.9	8.4	1	2	1	0	0	0	0	47.2	6
Apr.	143.0	76.0	18	7	6	3	2	1	0	85.1	7
May	240.0	35.3	22	19	18	9	4	0	0	277.1	15
Jun.	290.8	217.9	29	13	13	3	1	1	1	301.2	19
Jul.	185.2	66.0	21	12	10	6	2	2	0	459.2	22
Aug.	330.5	71.6	5	19	18	9	5	2	0	387.1	20
Sept.	376.2	66.0	21	20	20	11	5	2	0	383.5	20
Oct.	128.0	23.9	6	19	18	4	0	0	0	352.0	19
Nov.	578.8	285.0	19	23	22	11	4	3	1	262.6	14
Dec.	56.9	12.7	9	10	10	1	0	0	0	131.6	10
Annual	2399.1	285.0	XI-19	153	143	58	24	11	2	2851.5	165

Month 1964	TEMPERATURE (°C)								
	Mean	Mean Maximum	Mean Minimum	Highest	Date	Lowest	Date	Number of days with 35° or Above	Number of days with 21.1° or Below
Jan.	.	33.8	.	35.0	11	.	.	1	.
Feb.	27.0	32.1	21.9	34.4	24	18.9	17	0	13
Mar.	26.6	34.8	18.4	36.7	29+	16.1	16	13	29
Apr.	28.1	34.9	21.2	37.9	13	17.9	3	14	9
May	27.8	33.0	22.6	35.6	5+	21.4	15	3	0
Jun.	27.6	32.6	22.5	35.0	9	21.1	24+	1	2
Jul.	27.1	31.6	22.6	33.3	27	20.6	7	0	4
Aug.	26.9	31.4	22.3	35.3	1	20.6	9+	1	9
Sept.	26.5	31.4	21.7	32.2	14+	20.6	5+	0	9
Oct.	26.5	31.7	21.2	32.3	25	20.0	26	0	20
Nov.	26.0	31.3	20.6	32.8	3	18.9	30	0	23
Dec.	25.8	31.5	20.0	32.2	4	18.1	11	0	27
				37.9	IV-13	16.1	III-16	33	145

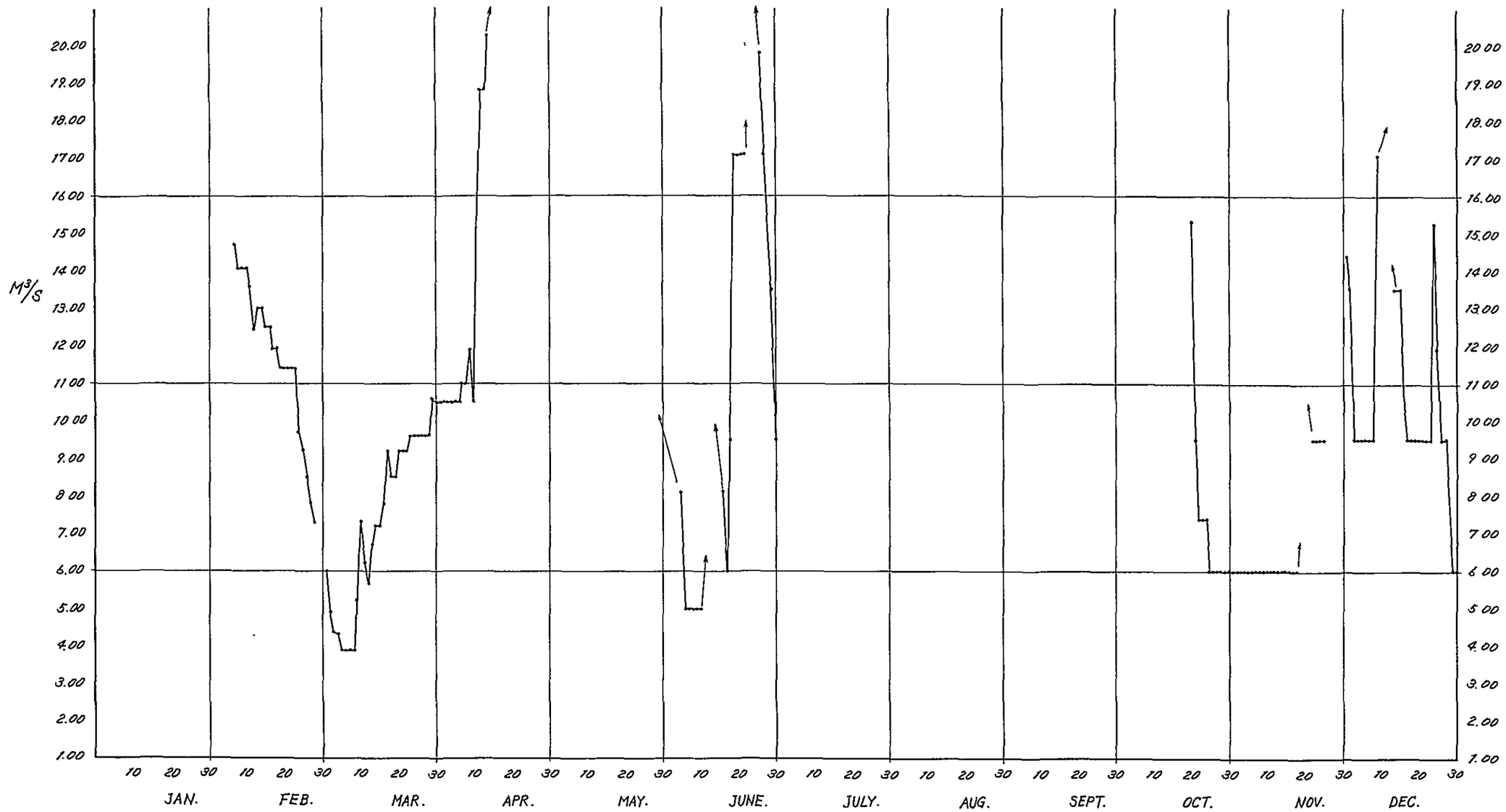
Graph 8. Discharge of the Bago River, 1957

The Point Surveyed : 10° 44' 30" N, 123° 02' 00" E
Basin : 683 km²



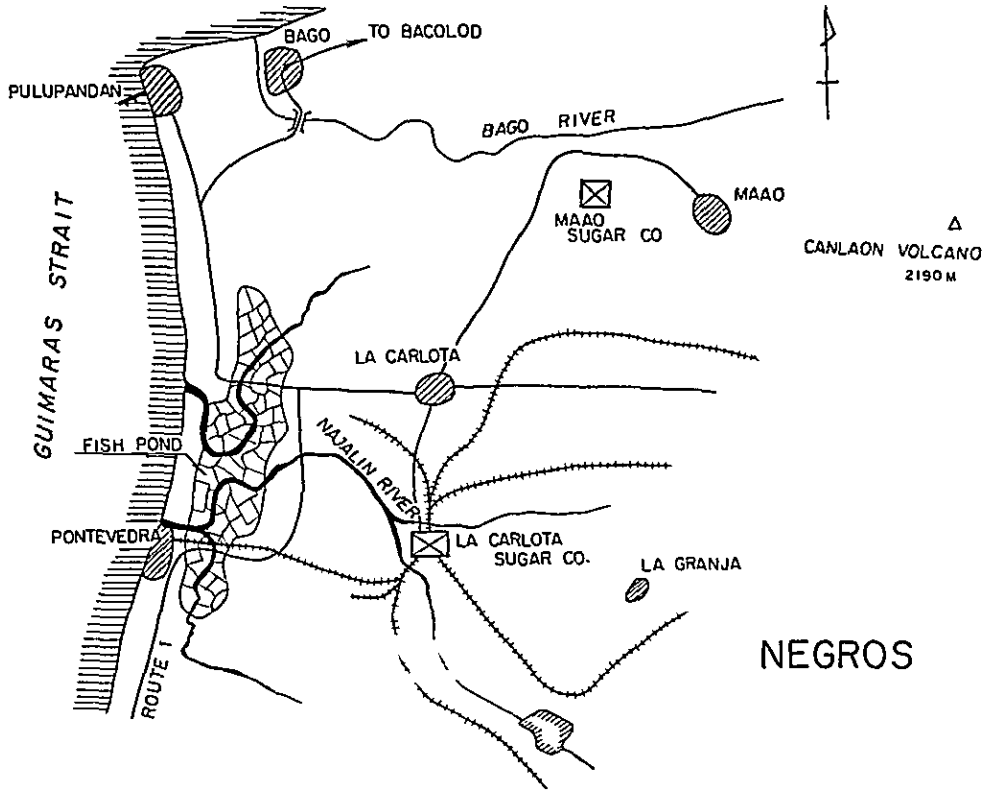
Graph 9. Discharge of the Bago River, 1969

The Point Surveyed : 10° 44' 30" N, 123° 02' 00" E
Basin : 683 km²



(9) Najalin River

Fig. 13

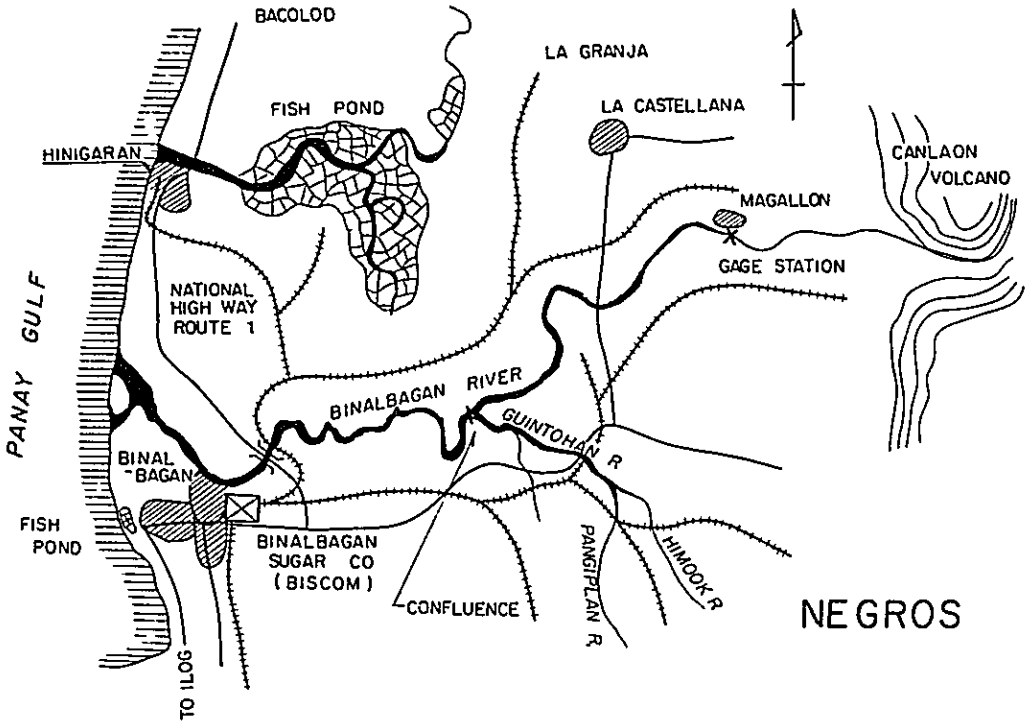


The Najalin is a small river in the area adjacent to the north of the Bago River described in the preceding (8). As there are many fish ponds around the mouth of this river, the discharge of waste water will pose a serious problem. Although the La Carlota Sugar Mill is located about 7 km up the estuary and gets water from this river, the discharge of the river is not sufficient and the supply of water to this mill is unstable.

No survey of the river discharge has ever been conducted. The shipment of products from the plant is made to the port of Pulupandon by truck. Judging from the above fact, this site is not considered appropriate for locating a mill.

(10) Binalbangan River

Fig. 14



This river, located about 30 km north of the Bago River which was already covered in the previous (8), originates in the south side of Canlaon Volcano, runs through the City of Biscom near its estuary and flows into Panay Gulf. In Biscom the Binalbagan Sugar Mill takes water from this river near the estuary (influenced by the sea water).

The gauging station is located in the town of Magallon approximately 30 km up the estuary and the drainage area measured at this point is 350 km^2. Further down from this point the Guintohan River and the Pangiplan River join this river and the basin increases threefold to 1,050 km^2.

According to the record of the 1959—1968 period (10 years) kept at the Magallon gauging station, the minimum discharge was 4.96 m^3/s in 1966 and 1.1 m^3/s in 1968 respectively. The cause of a drastic decrease in the discharge in December 1968 is still unknown and on this point it will be necessary to conduct a detailed survey. In other years the dry season was from March to May and the minimum discharge during this season was over 5 m^3/s.

At the point where two rivers meet each other the basin increases threefold and as a result, the discharge will also increase threefold, which is considered sufficient for the purpose.

For rainfall, see the record of precipitation attached to (8), Bago River.

If a pulp plant is to be constructed adjacent to the existing Binalbagan Sugar Mill, it will be necessary to provide an intake at the confluence on the upstream and to get water from that point by canal in view of the possible influence of sea water. Also for drilling wells, a plan should be worked out after making careful selection of the location.

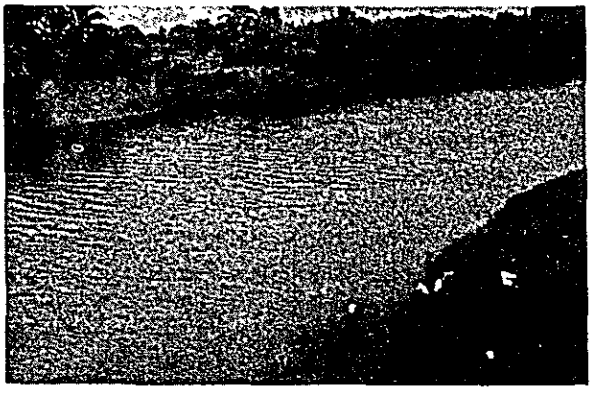
The products are transported to the port of Hinigaran by private railroad line. The port is equipped with fuel (oil) storage facilities, but the port area is limited in space. As for the existing facilities, modification will be necessary after making a detailed survey. At present, the cargo is loaded on barges with a crane and reloaded to ocean-going vessels at the Port of Pulupandan. This is considered one of the demerits of this site.

Although there are some fish ponds around the estuary, the problem of plant effluent may be solved through mutual agreement with local residents.

This area is under favorable condition in respect of industrial water and labor force and fully satisfies requirements for industrial location.

Efforts should be made in the future to conduct a survey and obtain statistical data in a further detail.

Binaldagan River



Monthly Run-Off 1959 ~ 1968, Binalbagan River

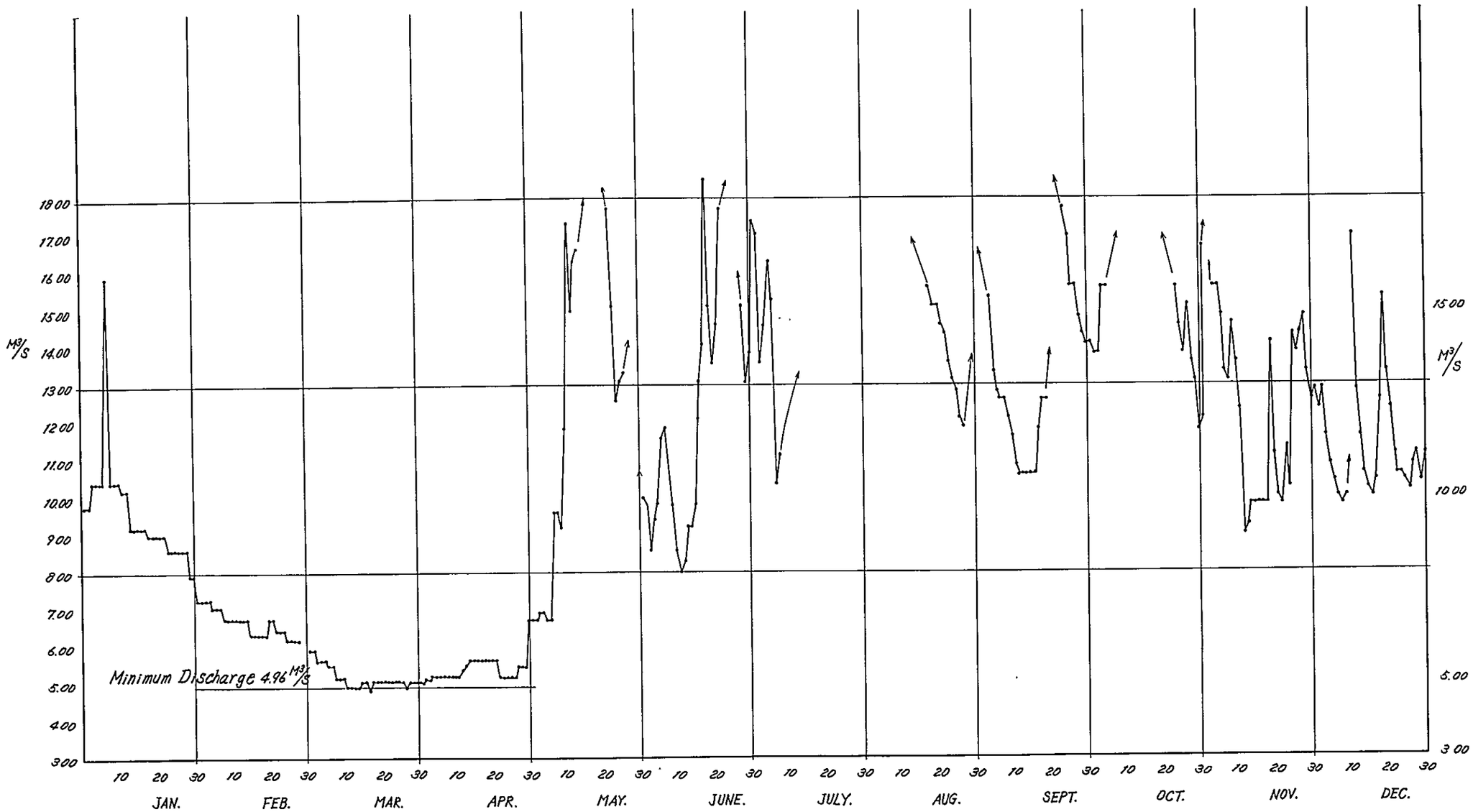
NEGROS

M³/S

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1959	-	-	177	165	218	375	1006	754	759	761	467	350	MAR 3240
1960	272	221	230	150	468	1212	624	872	998	-	839	455	APR 500
1961	380	316	313	293	667	782	850	1207	751	1128	561	481	APR 940
1962	396	361	340	397	433	453	1064	1175	952	777	600	417	APR 1000
1963	364	277	311	281	294	428	404	1243	602	930	423	440	MAY 826
1964	307	396	314	325	640	611	583	423	830	1135	1854	572	AUG 8.26
1965	479	341	437	374	354	628	996	728	745	659	361	363	MAR DEC 860
○1966	300	187	161	171	618	405	917	712	453	606	386	364	MAR 496
1967	896	333	418	216	168	239	621	1008	671	995	442	319	JUNE 480
○1968	206	197	174	120	117	167	192	413	944	898	1404	122	DEC 110

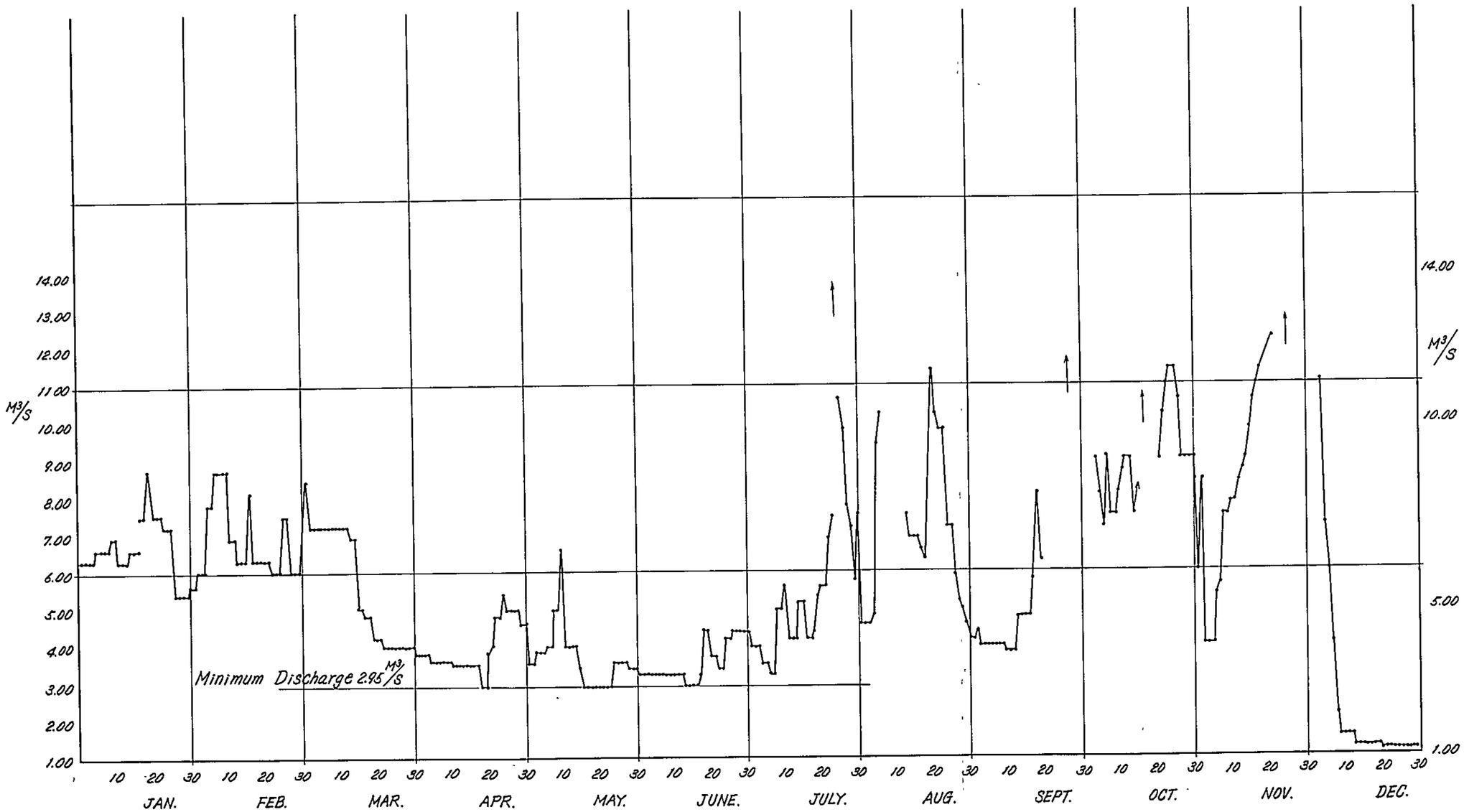
Graph 10. Discharge of the Binalbagan River, 1966

The Point Surveyed : 10° 15' 36" N, 123° 05' 05" E
Basin : 350 km²



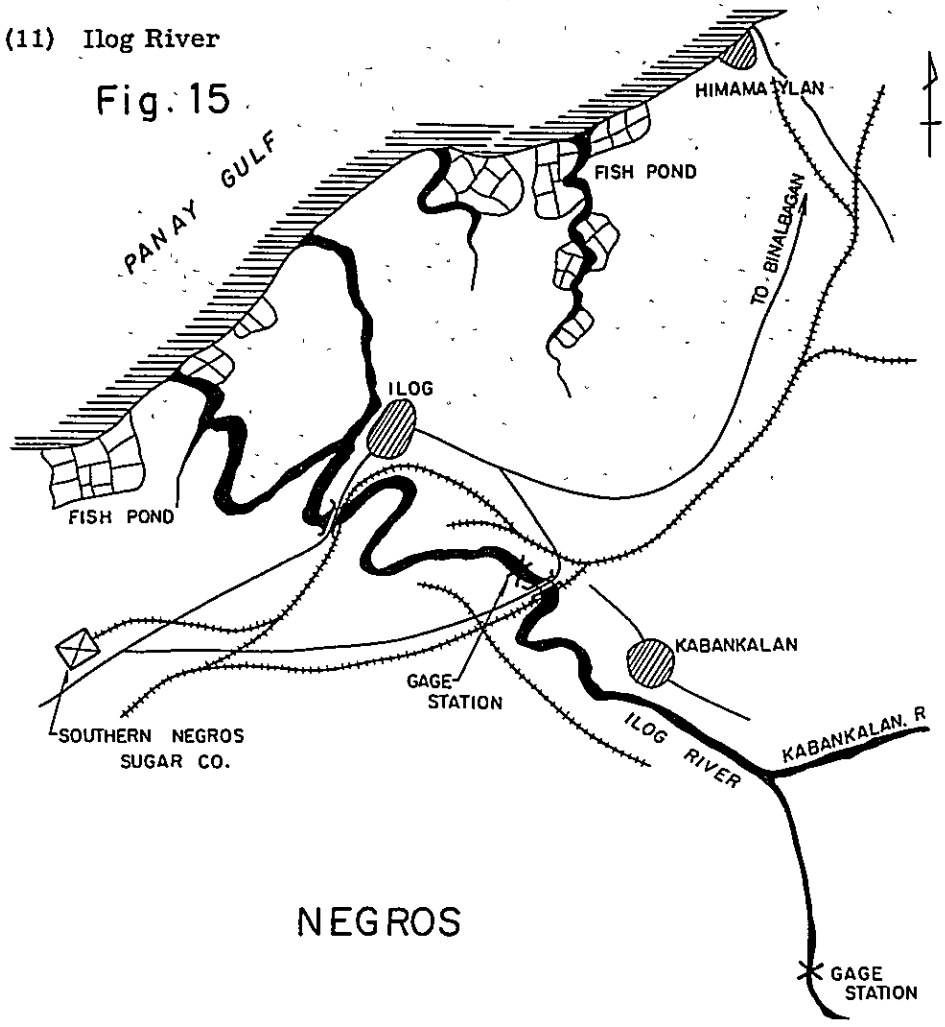
Graph 11. Discharge of the Binalbagan River, 1968

The Point Surveyed : 10° 15' 36" N, 123° 05' 05" E
Basin : 350 km²



(11) Ilog River

Fig. 15



The Ilog River, the largest river on Negros Island, is situated in the center of Negros south and its basin near the estuary extends over 2,060 m^2.

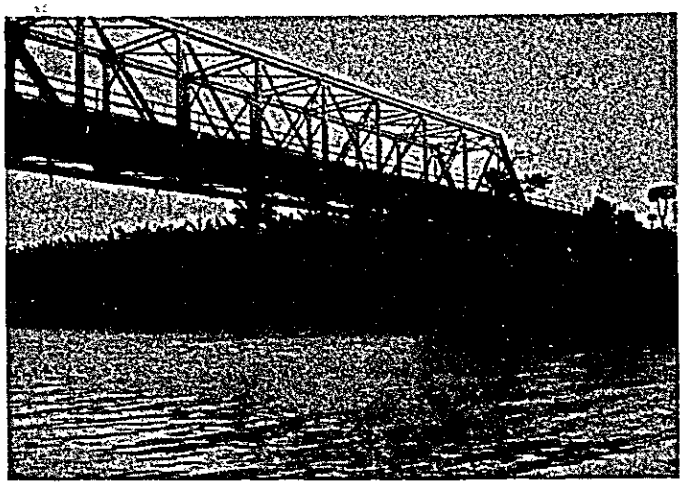
The gauging stations at ten locations keep the record of discharge. The gauging station selected for this survey was on the Ilog River 10 km up the confluence of the Ilog River and the Kabankalan River where there was no effect of sea water and the results of measurement are illustrated graphically.

According to the record covering 13 years from 1957 to 1969, the minimum discharge was 3.25 m^3/s for 1962 and 5.4 m^3/s for 1969. The Southern Negros Sugar Mill located at the point 4 km south of Ilog City takes water from this river.

The discharge of this river is sufficient for the project.

In this area there is no port worth mentioning and the products are transported to the Port of Himamaylan by private railroad.

In the future development of the Ilog Plain and economic growth of this area with full use of this river are highly expected.



Ilog River

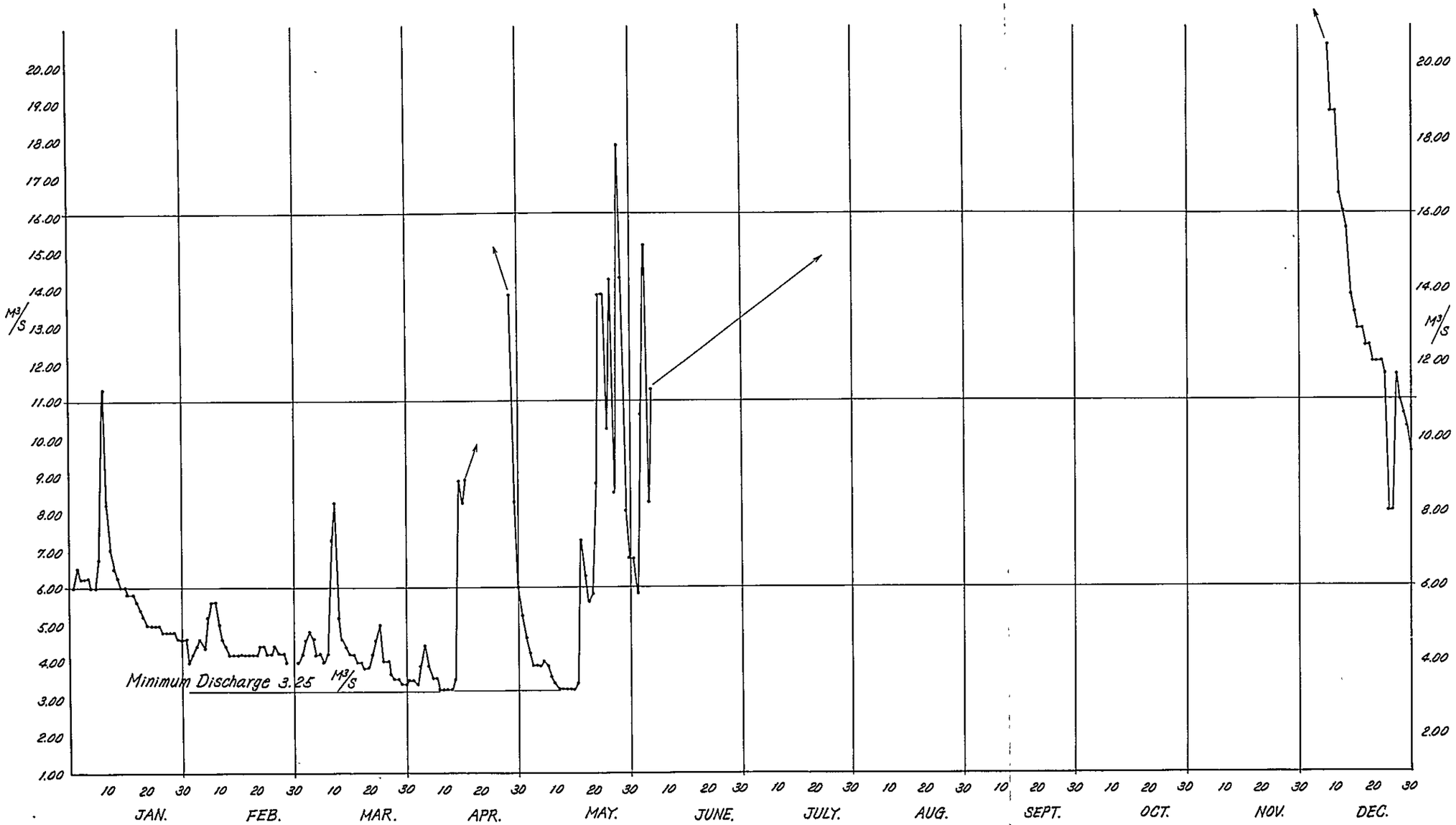
Monthly Run-Off 1957 ~ 1969, Ilog River

NEGROS M³/S

		FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1955													
1956													
1957	2277	-	370	270	292	848	1689	3072	1766	1902	739	311	821
1958	219	170	173	167	437	806	-	1832	2754	2940	3416	740	500
1959	309	220	210	236	366	1107	4963	5873	2748	4853	1245	847	600
1960	316	263	216	343	781	2854	-	-	-	-	-	-	-
1961	-	-	-	114	257	1888	-	-	-	2051	-	317	
○1962	182	124	136	361	208	916	3590	1637	3154	1588	1390	564	APR 3.25
1963	259	154	161	135	216	1431	1321	1272	2470	3598	841	1215	APR 4.20
1964	473	379	352	472	2030	1090	1017	2818	3956	3621	4634	1388	APR1040
1965	840	381	376	930	1309	3237	3414	3699	3387	2654	1380	454	MAR 8.86
1966	265	190	191	230	1505	2448	3228	2235	1908	2547	-	-	APR 4.68
1967	1065	581	706	371	862	986	3701	2259	1683	5515	1688	622	APR 8.85
1968	378	337	301	227	746	1132	2863	3562	2880	1687	1007	484	APR .650
○1969	275	189	194	173	545	1223	2676	2937	3047	2321	710	682	APR MAY 540

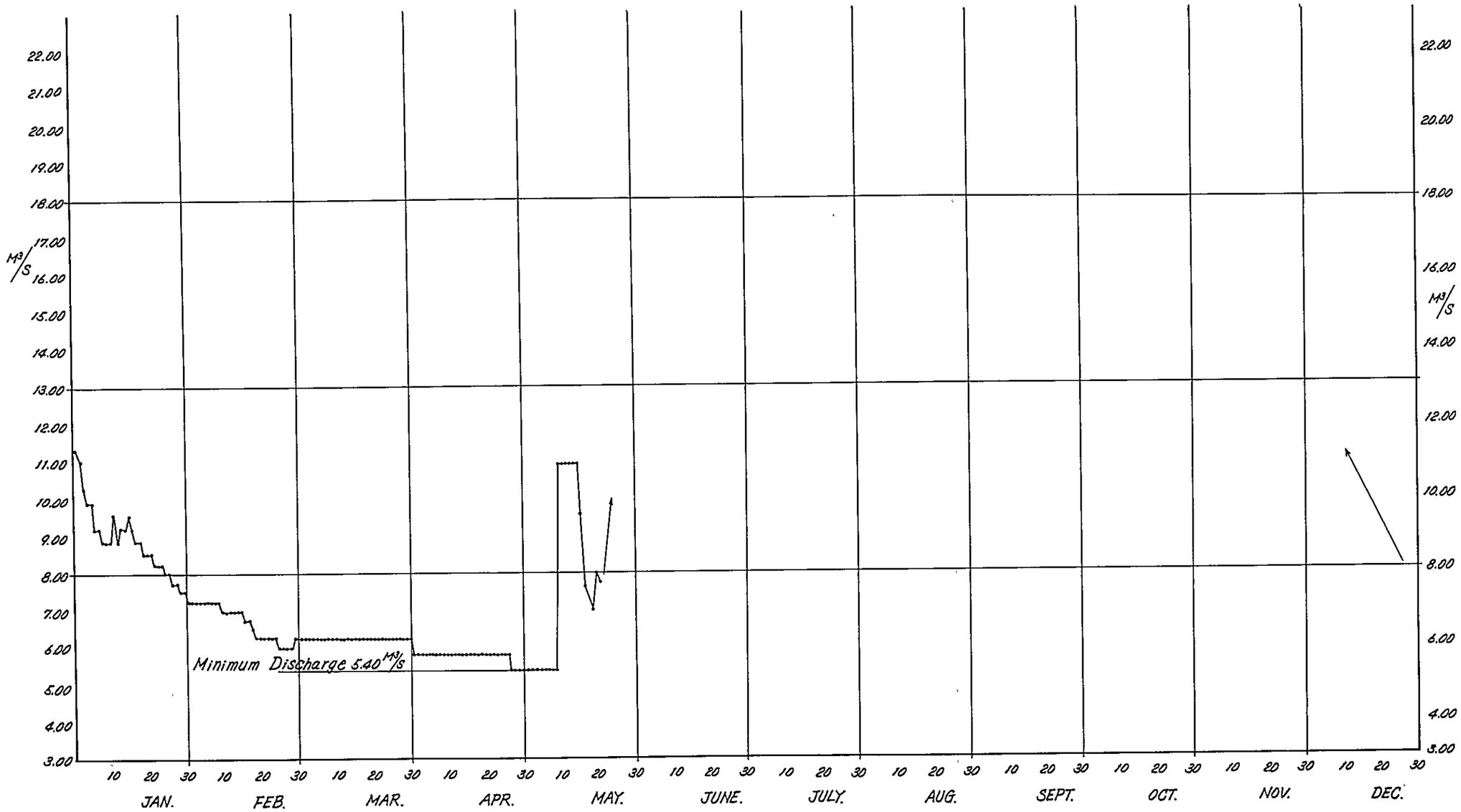
Graph 12. Discharge of the Ilog River, 1962

The Point Surveyed : 9° 53' 20" N, 122° 50' 40" E
Basin : 1390 km²



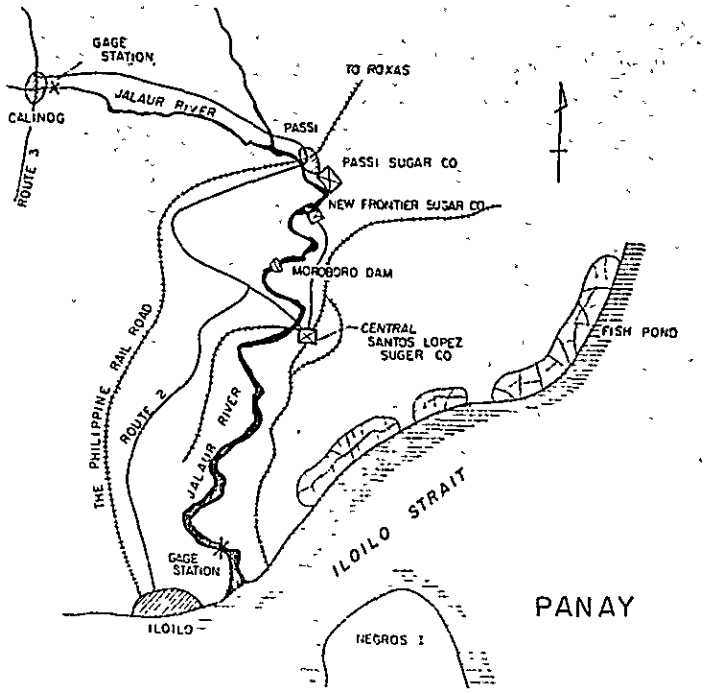
Graph 13. Discharge of the Ilog River, 1969

The Point Surveyed : 9° 53' 20" N, 122° 50' 40" E
Basin : 1390 km²



(12) Jalaur River

Fig. 16



This river, one of the three major rivers in Panay, originates in the central mountain area and has its estuary in the City of Iloilo in the southern Panay. The discharge survey is being conducted at eight locations.

The basin at the point 7 km up the estuary is 1,600 km^2. The Santos Lopez Sugar Mill located 20 km up the estuary takes water from this river. 6 km further up the river there is Moroboro Dam, a multipurpose dam, (32 water gates 5 m in dimension, 10 irrigation water gates 3 m in dimension, a fish ladder, reinforced concrete in construction) which is primarily used for irrigation of rice fields.

About 20 km farther up the river there are the Passi Sugar Mill and the New Frontier Sugar Mill, both of which are getting water from this river.

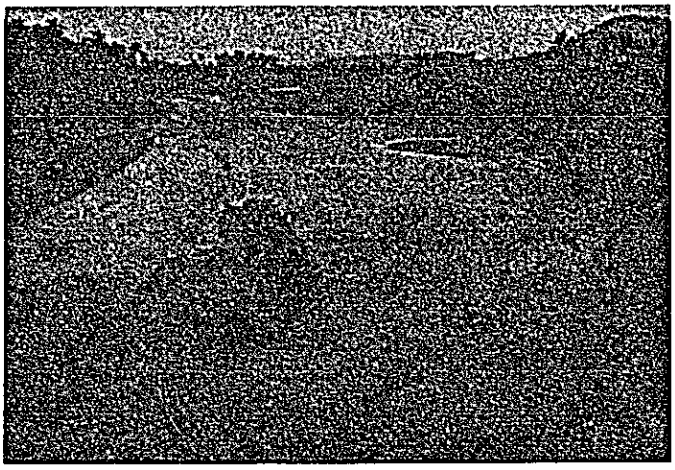
The record of the discharge kept at Calinog gauging station on the upper reaches for an 8-year period from 1957 to 1964 is available. According to the record, the minimum discharge was 1.9 m^3/s in 1959 and 2.1 m^3/s in 1964. According to the discharge diagram, there is rainfall every other day and the area is considered to be of high precipitation. The discharge of the river at the points where sugar mills are located is considered sufficient for the purpose.

As for water use, a more detailed survey will be required.

For transportation, the Philippine railroad, the only passenger railrad line in the Philippines, running across Panay from north to south, is available.

The products are transported to the Port of Iloilo by truck for shipment.

This area is not considered appropriate in view of the avilability of raw material and the site being located deep in the mountain area.



Jalaur River

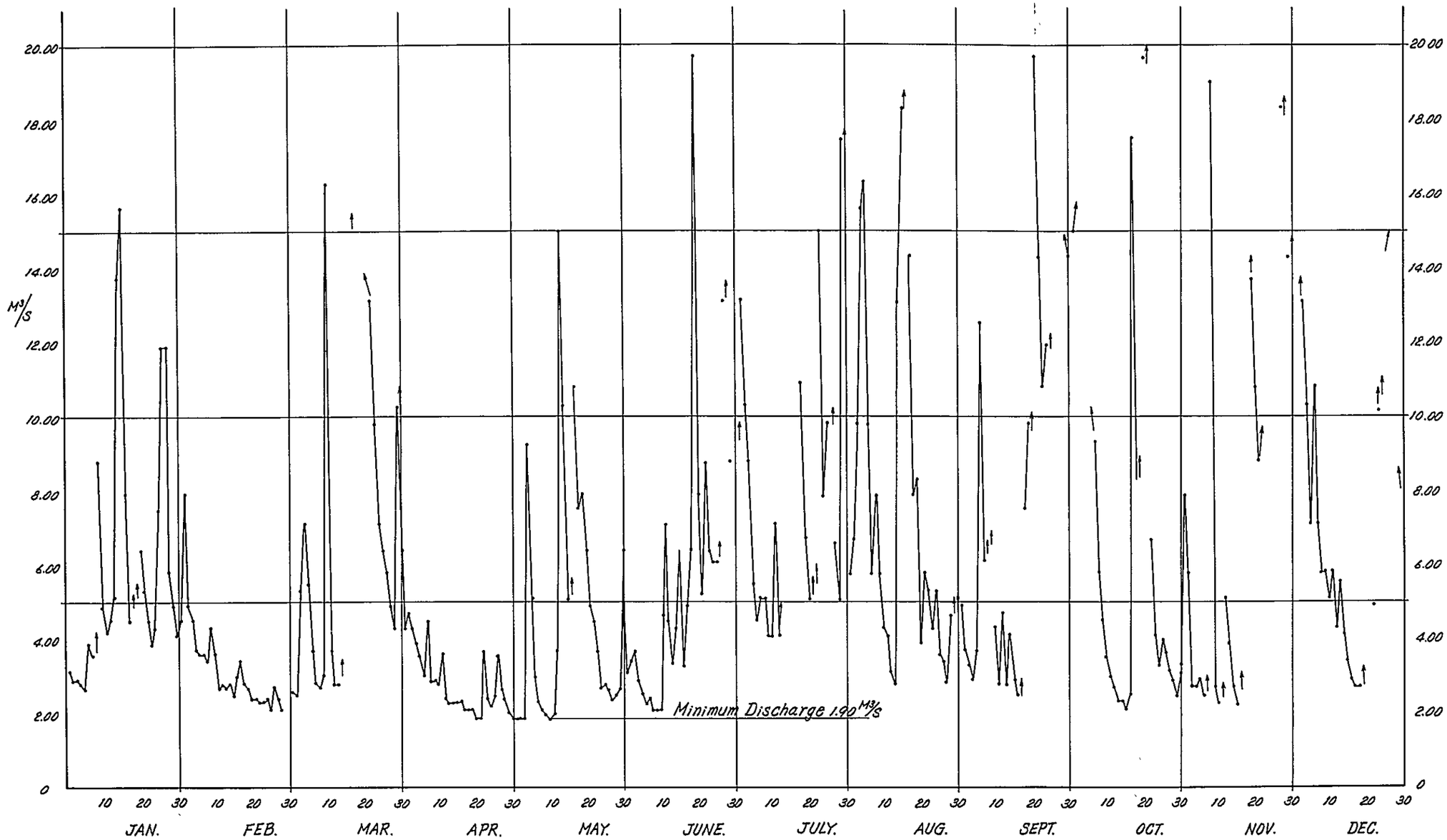
Monthly Run-Off 1957 ~ 1964, Jalaur River

PANAY M³/S

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1957	1297	288	131	268	117	120	693	525	559	320	526	156	MAR 255
1958	253	214	189	265	165	137	274	196	141	1102	668	263	MAR 230
○1959	238	91	352	86	195	244	636	303	678	372	1249	695	MAY 193
1960	474	669	263	839	432	759	537	830	625	1093	1232	459	DEC 265
1961	355	371	117	141	297	606	793	1316	547	846	778	859	APR 246
1962	379	397	340	238	259	868	1230	905	875	525	1052	1053	FEB 350
1963	812	474	213	183	477	498	671	1065	710	461	386	1011	MAR 427
○1964	405	679	256	186	603	622	1121	767	496	819	2236	510	MAR 214

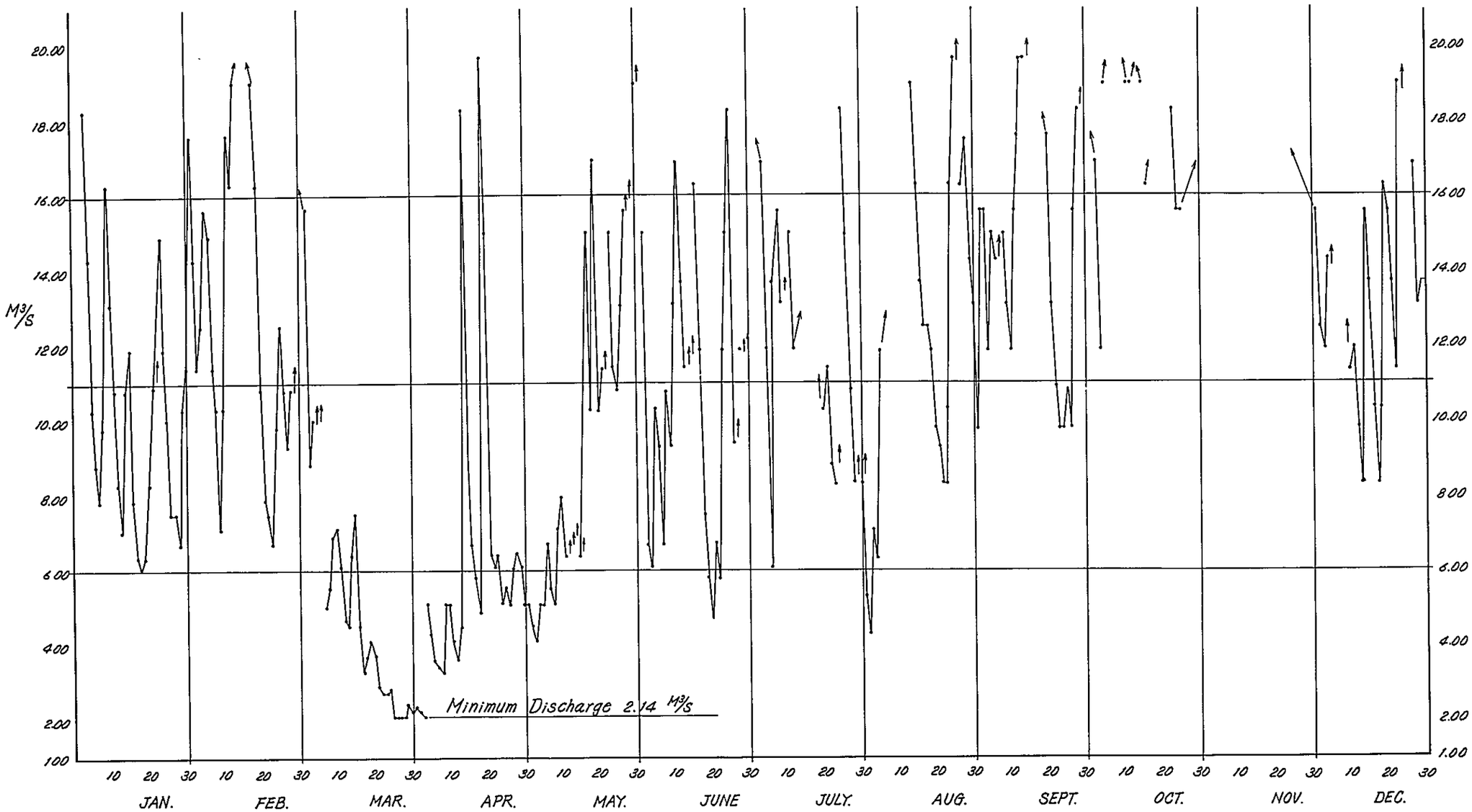
Graph 14. Discharge of the Jalaur River, 1959

The Point Surveyed : 11°07'15" N, 122° 31' 45" E
Basin : 169 km²



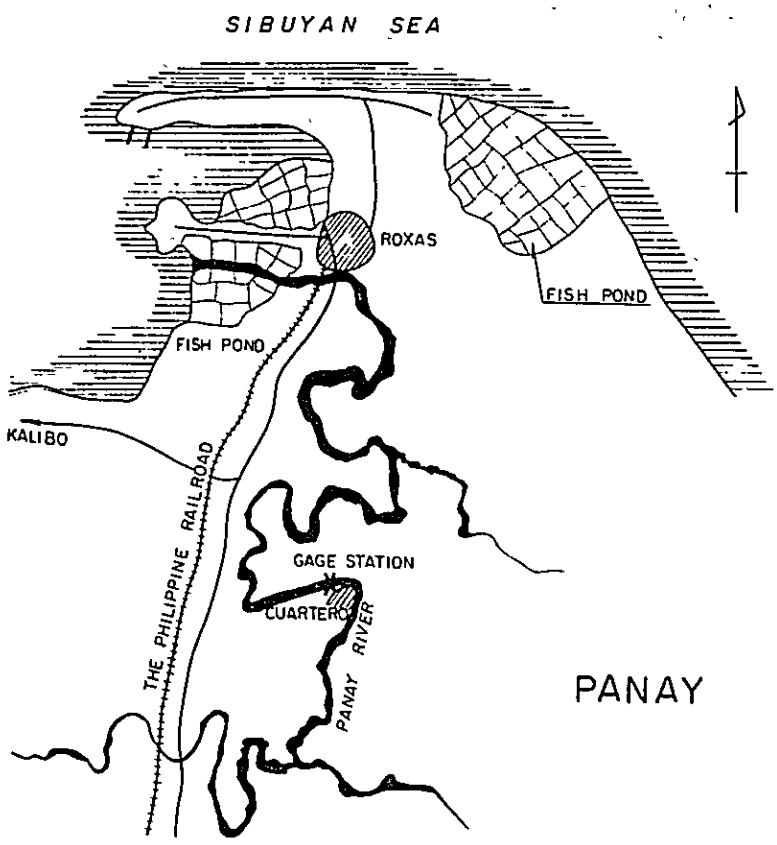
Graph 15. Discharge of the Jalaur River, 1964

The Point Surveyed : 11° 07' 15" N, 122° 31' 45" E
Basin : 169 km²



(13) Panay River

Fig. 17



This river, one of the three major rivers in Panay, has its estuary in the City of Roxas at the north tip of Panay Island. As shown in the above sketch, the river has a slow grade and winds at many points. During the rainy season, the whole river course turns to a retarding basin and causes frequent inundation.

Despite of its abundant discharge and large basin, the river does not seem to be in wide use because of the constant threat of flood.

At the point above 50 km up the river from the estuary there is the Asturia Sugar Mill.

The drainage area measured at Cuartero, about 50 km upstream from the estuary is 880 km^2. A record of the discharge for a period of 8-years from 1957 to 1964 is available. The minimum discharge recorded was 3.3.m^3/s in 1959 and 4.4 m^3/s in 1960. Judging from the availability of raw material and the location of the site which must be selected deep in the mountain area, this area is not considered appropriate for the project.

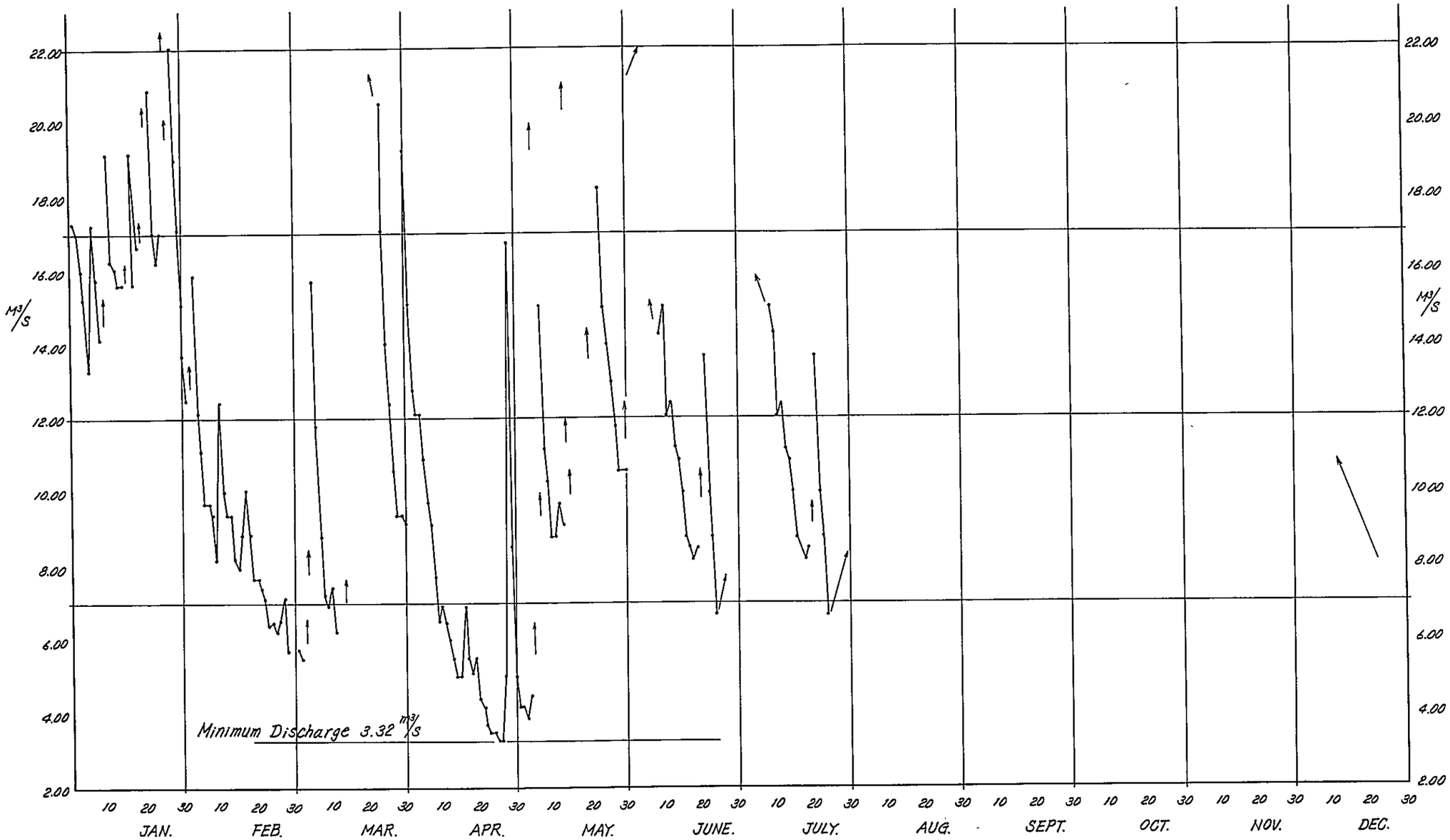
Monthly Run-Off 1957 ~ 1964, Panay River

PANAY M³/S

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1957	5151	850	430	1053	352	775	2358	2107	1361	1964	1325	598	JUNE 602
1958	748	346	322	474	563	1112	1572	1984	934	4841	4125	1603	MAR 5.08
○1959	593	279	763	216	1167	893	3907	1824	3152	3287	3582	2344	APR 3.32
○1960	670	759	399	1749	855	2036	2485	2014	1142	3225	4727	1830	APR 442
1961	1147	615	397	259	756	1229	1835	1433	1780	3132	1988	995	APR 710
1962	1095	779	882	288	263	1533	3190	3475	5968	1335	3660	3160	MAY 530
1963	1880	831	455	273	234	239	666	2802	1533	1804	1328	2412	MAY 590
1964	776	-	-	197	813						4351	3156	-

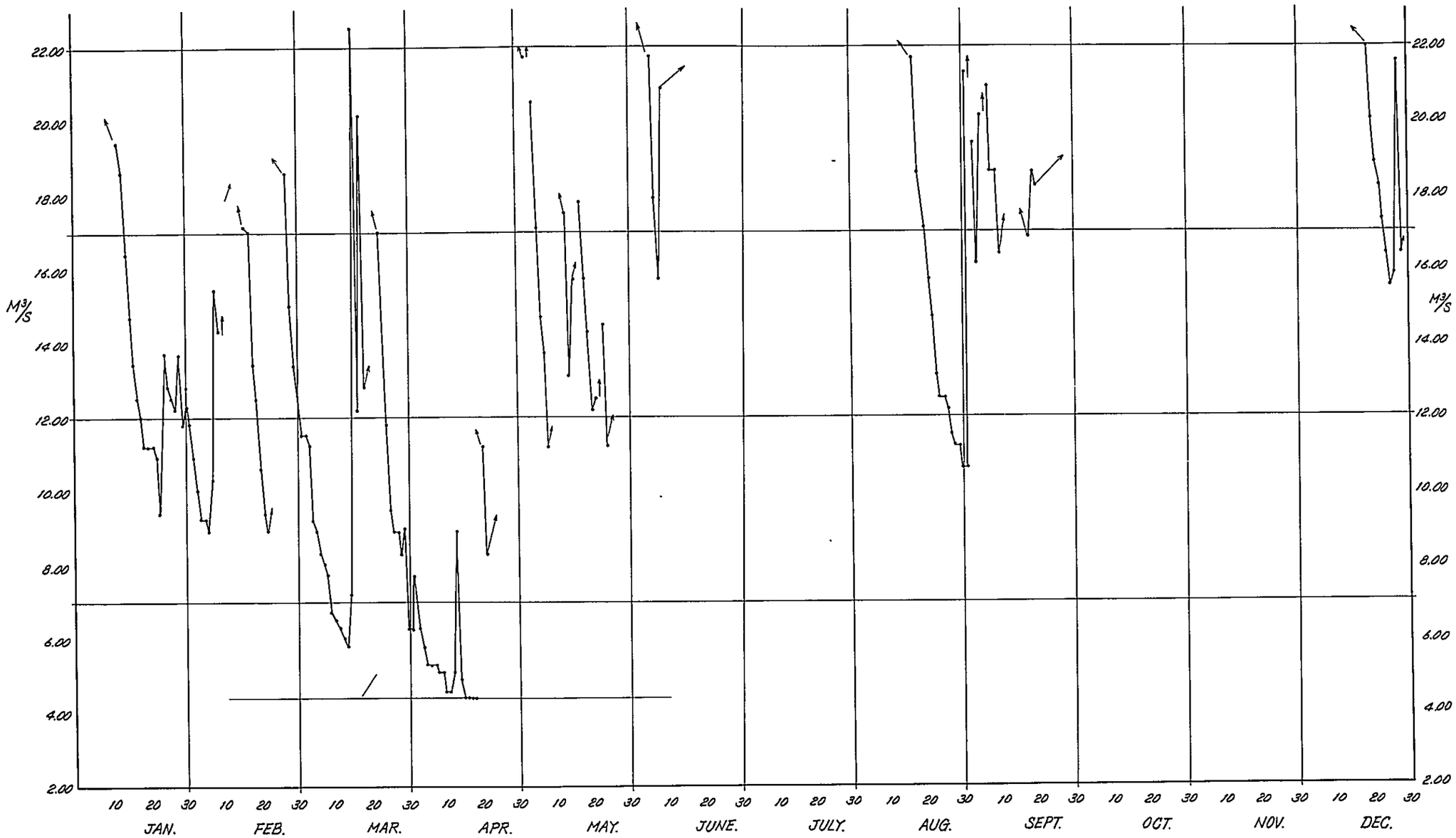
Graph 16. Discharge of the Panay River, 1959

The Point Surveyed : 11° 17' 13" N, 122° 35' 31" E
Basin : 880 km²



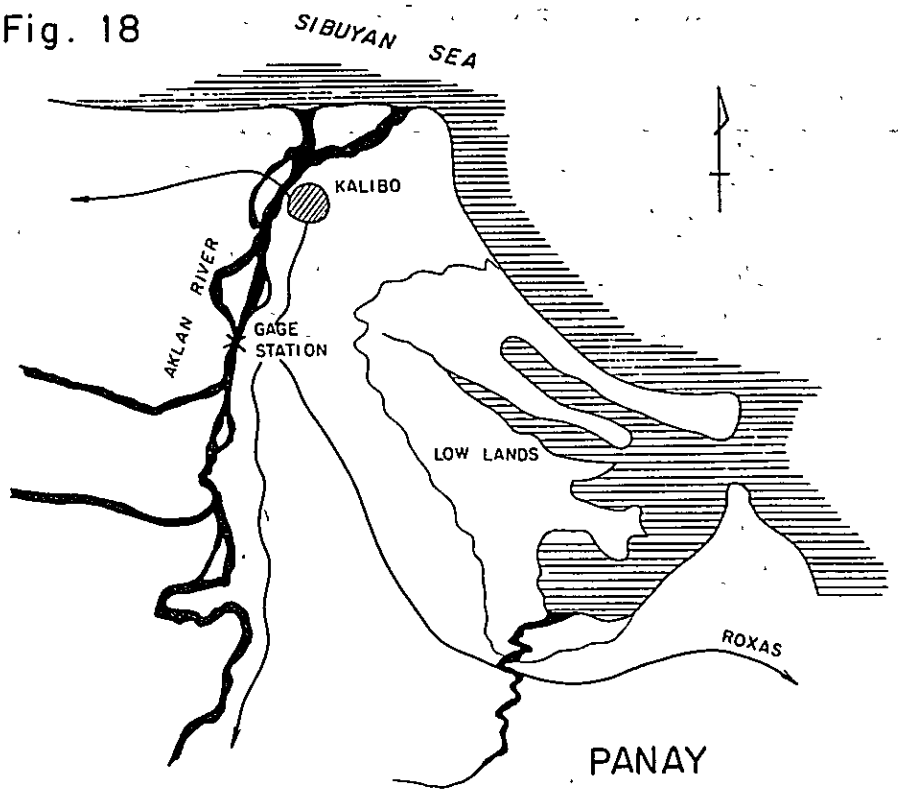
Graph 17. Discharge of the Panay River, 1960

The Point Surveyed : 11° 17' 13" N, 122° 35' 31" E
Basin : 880 km²



(14) Aklan River

Fig. 18



This river, one of the three major rivers in Panay, is situated in the northwestern section of Panay Island. As shown in the above sketch, the river meanders at many points and because of lack of a river improvement project, the river bank collapses at every flood and the width of the river expands considerably, measuring one kilometer at a certain point.

The drainage area at the gauging station is 705 km^2.

A record of the discharge for a period of 13 years from 1957 to 1969 is available. According to the record, the minimum discharge of 9.2 m^3/s was recorded in 1969. In other years the minimum discharge was over 16 m^3/s, which is considered sufficient.

In this area rice cultivation prevails and there are good canals which were constructed under the Irrigation Project for rice fields.

Development of this area should be planned after making a detailed study on the water use of this river.

Monthly Run-Off 1957 ~ 1969, Aklan River

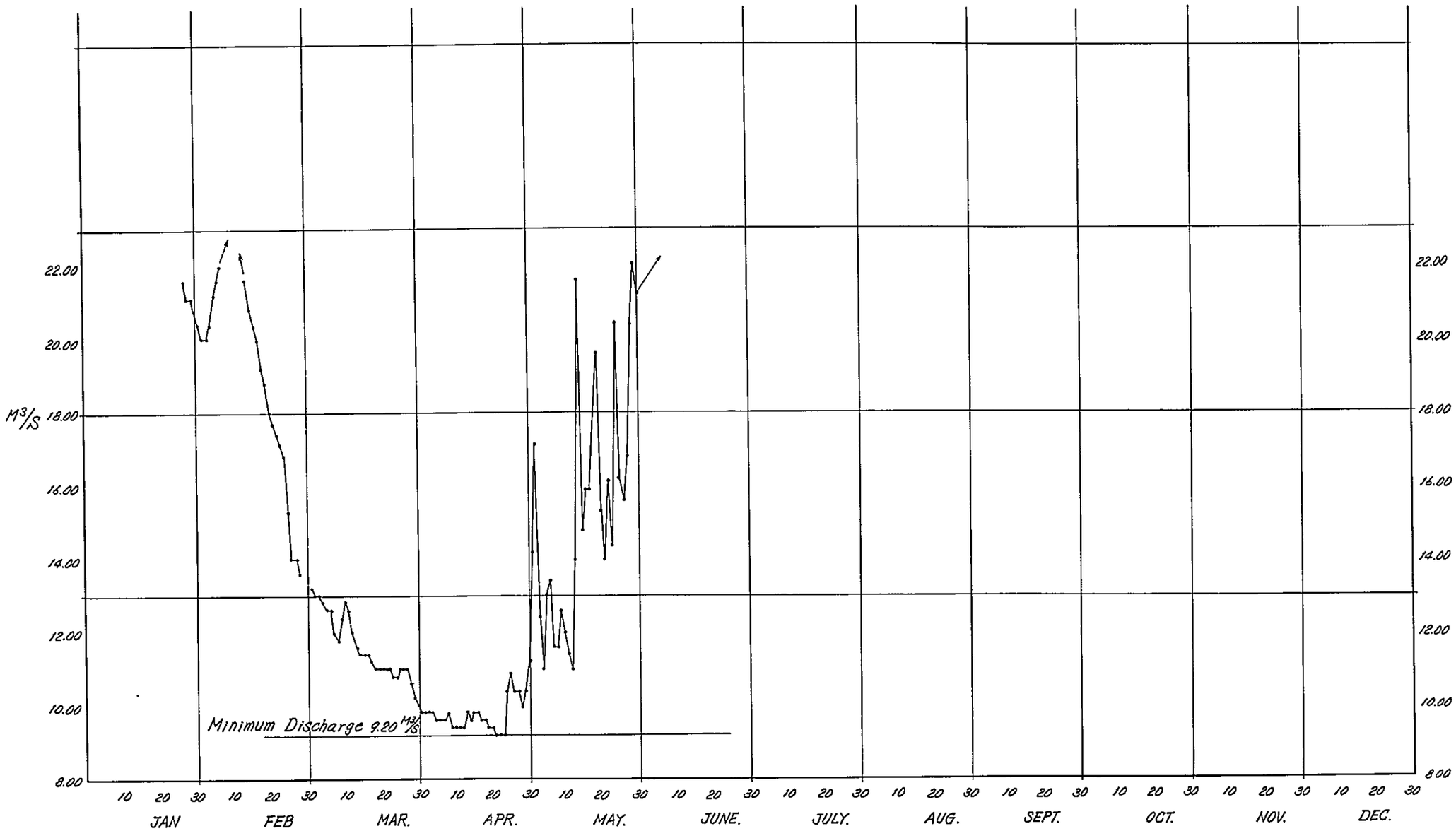
PANAY

M³/S

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Min.
1957	8150	3442	1817	3105	981	978	4061	3427	3773	3212	2900	2322	NOV 16.34
1958	4269	-	-	-	-	-	2797	2478	1660	4513	-	2921	-
1959	2937	1198	3486	1073	1682	2072	3551	2960	1534	2686	5773	6125	APR 2624
1960	5459	4092	-	-	1232	2478	2573	3007	1485	4778	6053	-	MAY 21.83
1961	-	-	-	983	1194	1283	1839	2704	1244	2097	2720	2142	MAR 2260
1962	2980	2677	2246	741	847	1244	2773	3940	3828	2682	3806	4407	APR 2160
1963	4497	3428	2934	1911	1883	-	1850	2980	2676	2621	3533	3360	JULY 4360
1964	2699	3157	2349	2506	2466	3121	2477	2047	2162	2231	2811	3546	APR 4060
1965	2447	2012	2150	1838	1603	1388	-	-	1686	2552	2431	3768	-
1966	2447	1435	1596	1442	2985	1834	2406	2030	-	-	-	-	-
1967	4251	2337	1914	868	706	1066	1508	1534	1106	1390	2634	2196	JUNE 17.70
1968	2443	1574	1515	901	954	1334	1799	2116	962	1260	1928	1830	APR 2320
○1969	1967	569	359	294	485	909	2269	2274	1871	1754	1706	3267	APR 9.20

Graph 18. Discharge of the Aklan River, 1969

The Point Surveyed : 11° 35' 23" N, 122° 18' 14" E
Basin : 705 km²



Suitability of Each River For Factory Location

	Existing Sugar Mill	Industrial water available: Yes or No	Road Condition	Railway	Port and harbour	Underground water	Plant effluent	Rating
Bucao River	Carebi Sugar Mill	Yes. Canal is short.	National Route 7 available	None	Masinloc Port 40 km from the mill. Oil storage facilities available	Hopeful	Discharged to the river. No fish pond.	Quite suitable.
San Cristobal River	Canlubang Sugar Mill	No.	National Route 17. Close to Manila City	Service between Manila and Batangas	Port of Manila available	Hopeful. Industrial water totally relied on spring water and underground water.	Discharged to Laguna de Bay. Some problems.	Not suitable.
Benabang River	Batangas Sugar Mill	No extra capacity in discharge	National Route 17. Truck service available	Private railway	Port of Wawa in Nasugbu 25 km from the mill available.	Available	Discharged to the river. No specific problem.	Not suitable.
Agus River	No sugar mill. Lanan pulp & paper mill, cement plant, hydro power station, carbide plant, caustic soda plant	Sufficient water supply	National Route 1 coastal highway	None	Port of Iligan available. Construction of quay walls for exclusive use possible.	Hopeful	Discharged to the river. No fish pond. No problems.	Not suitable because of unavailability of bagasse. Suitable for other industries.
Tanjay River	Bais Sugar, Bagasse & Pulp Plant	No extra capacity in discharge	National Route 1 and coastal highway available	Private railway. Private one to the port.	Quay walls for exclusive use available at Luca Port	Available but requires a further study.	Discharged to other creeks. Effluent is brown in color. Some fish pond. No problems.	Not suitable
Himogaan River	Lopes Sugar Mill	Yes. (But no previous record)	National Route 1 available	Private railway	No port available. This river is used for transportation. Barge ocean-going vessels anchored off-shore.	Available		Suitable but not quite.
Malogo River	Victorias Sugar Mill	Yes Diversion from other rivers	National Route 1 available	Private railway	No port available. Creeks being used. Barge ocean-going vessels anchored off-shore.	Available but requires a further study.	Discharged to other creeks. Although there are some fish ponds, no specific problems are encountered.	Suitable but not quite.
Bago River	Ma-ao Sugar Mill	Yes.	National Route 1 available	Private railway. Private one to the port.	Excellent Pulupandan Port available	Available	Discharged to the river. Although there are some fish ponds, no specific problems are encountered	Quite suitable
Najalin River	La Carlota Sugar Mill	No.	National Route 1. Transportation to the port by truck (25 km)	Private railway	Pulupandan Port available	Available	Discharged to the river. Many fish ponds and some problems.	Not suitable
Binalbagan River	BISCOM Sugar Mill	Yes	National Route 1 available	Private railway Line laid to the port.	Hinigaran Port available for exclusive use. Barge Pulupandan Port is also available.	Available but requires a further study.	Discharged to the river. Some fish ponds but no specific problems.	Suitable
Ilog River	Southern Negros Sugar Mill	Abundant discharge	National Route 1	Private railway	Unknown	Unknown	Unknown	Not suitable
Panay River	San Juan Sugar Mill	Abundant discharge	Not complete	Railway available	Roxas Port available	Unknown	Unknown	Not suitable for pulp plant. Suitable for marine products industry.
Aklan River	None	Abundant discharge. Irrigation water being used.	Not complete	No railway	No port available. Port construction being planned	Unknown	Some fish ponds	Not suitable for pulp plant.
Jalaur River	Santos-Lopez Sugar Mill	Discharge from the dam being used.	Not complete. Products transported to Iloilo Port by truck.	No railway	Iloilo Port available	Available	Some fish ponds but no specific problems as plant effluent is discharged upperstream.	Not suitable for reasons of their location being far from coast.
	Passi Sugar Mill	Yes	Not complete. Products transported to Iloilo Port by truck.	No railway	Iloilo Port available.	Available	Same as above.	
	New Frontier Sugar Mill	Yes	Not complete, Products transported to Iloilo Port by truck.	No railway	Iloilo Port available.	Available	Same as above.	

Notes. 1. Low cost labor force is more than sufficient.

2. For plant effluent, appropriate facilities are to be provided under any circumstances.

3. Plant water facilities are to be provided. For use of groundwater, sand basins are to be provided.

4. For domestic water and power supply, own facilities are to be planned.

1.1.2 Quality of River Waters

The quality of river waters is as important as the discharge of the river.

The survey team conducted a water quality analysis for each river with a portable water quality analyzer (Manufactured by Kurita Water Industries, Ltd.). Although the number of test items was limited and the accuracy of the value obtained by the analysis may not be guaranteed because of the performance (type) of the analyzer, general tendencies may be pointed out.

On the other hand, the data on the amount of plant water requirements and the results of water quality analysis for each sugar mill were obtained during the inspection tour of the sugar mills and efforts were also made to gather data on the discharge and the results of water quality analysis for each river from the Bureau of Public Works to the extent possible.

The results of these water quality analyses are summarized into a table which will be shown below.

Although each test organization conducted analyses on pH and chlorine ion, there are considerable differences in the test items depending on individual organization.

It is to be noted that the table shows high values of total hardness and total alkalinity compared with the river waters in Japan and the high value of sulfate ion indicates the fact that the catchment basin of the river belongs to the volcanic zone. It is desired that more diversified water quality analyses be made in both the dry and rainy seasons.

The following is the analysis on river waters.

Analysis on River Waters

Name of River		Bucao	Himogaan		Sicaba	Malogo		Bago			Malacandang	Najalin	Binalbagan	I l o g				Aklan	J a l a u r				Tanjay	A g u s
Sampling points		Botolan (Carebi)	Fabrica (Lopez)	Route 1 Near bridge	Route 1 Near bridge	Victorias Sugar mill	Route 1 Near bridge	Route 1 Near bridge	Lat 10°44' 30"N Long. 123°02' 0"E		Ma-ao	La Carlota	BISCOM	Route 1 Near bridge	Route 1 Near bridge	Lat. 10°01' 30"N Long. 122°45' 14"E		Gauging station	Passi	Lat 10°55' 50"N Long 122°40' 10"E		Santos-Lopez	Bais	I l i g a n
Analysis made by:		Sugar mill	Sugar mill	Survey team	Survey team	Sugar mill	Survey team	Survey team	B P W		Sugar mill	Sugar mill	Sugar mill	Survey team	Survey team	B. P. W		Survey team	Survey team	B. P. W.		Survey team	Sugar Mill	Rustan Pulp & Paper Mill
Date of sampling		Feb 27, 71		Mar. 5, '71	Mar. 5, '71	Apr. 30, '71	Mar 5, '71	Mar. 6, '71	Mar 7, '70	May 10, 70		Mar. 1, '70	Jun. 11, '70	Mar. 8, '71	Mar. 8, '71	Feb 25, '64	Jun 17, '64	Mar. 12, '71						
Water temperature	Degree																							
Color	"											3 7												
Turbidity	ppm								30	15	10	5.8	75			2	25			10	40		10	
pH		8 2	7.5	6.4	6 8	7.0	6.6	6.8	-	8.7	6.5	7.09	7 1	6.8	7.8	7.1	7.0	6.6	6.4	8 3	8.5	6 8	7 9	7.5
Cl	ppm	10 2	nil	8 5	6.5	9 9	8.0	6.0	216	23	31	5 5	55 4	17	72	36	11	4	80	36	27	100	.	64.85
Total hardness	"	480	20	24	23		37.0	51 0			127	67.2	470	156	204			46	150			212	120	62
Total alkalinity	"	60	60	30	30	32	34.0	56 0	380	219				116	164	107	60	50	162	249	81	232	100	
M alkalinity	"	60		30	30		34.0	56 0				63 6	38 4	116	164			50	162			232	100	62.59
P alkalinity	"			0	0		0	0						0	0			0	0			0	0	
Specific conductivity	MMHO								630	590		139	950			335	287			344	294			
Dissolved solids	ppm		1450						441	413			774			234	200			241	206			
CO3	"								55	41	10					0	0			28	15			
HCO3	"								71	71	10	63.6				131	73			228	68			
Ca	"					20 8					9	31.2												11 20
Mg	"					11 2					33	36.0												8.26
SO3	"			nil	nil		nil																	
SO4	"					6.7					86		182											
SiO2	"										20	29.5	47.3											
Fe	"					2.1						0.34	0 5											
Mn	"												0.05											
KMnO4 consumption	"												2.853											

1.1.3 Present use and Future Development of River Water

Of the many rivers, large and small, observed during the survey period, most are natural rivers and the development of them is the question for the future.

The electric power demand in local city area is met mainly by the supply from thermal power plants and kerosene lamps seem to be in general use in the rural area just outside the city area.

It seems that there are very few hydroelectric power stations making the use of the head of river water in this area.

The power plant at the Maria Cristina Fall on the Agus River in Mindanao is one of the largest hydroelectric power plants in the region.

The Maria Cristina Fall, situated about 1.8 km upstream from the estuary, has a head of about 30 m.

An intake and a regulating basin are provided above this fall and the water is led to the power plant located below the fall by penstock. The capacity of the power plant is said to be 150,000 KW.

The power generated by this plant is supplied to an iron and steel works, Mabuhay Vinyl Plant, a caustic soda plant, a pulp and paper mill and cement plant located along Iligan Bay and plays an important role as driving force in the so-called Iligan industrial area. Judging from the distance between Lanao Lake and the estuary of the Agus River and the difference of altitude between the lake water and sea water levels, the grade of the Agus River is presumed to be 1/100—1/200 and the river is considered to be under very favorable condition for the construction of a hydroelectric power plant.

Through development of this water resources, there is a possibility of growing industries of mass industrial water consumption.

Although the site of hydroelectric power plant may be selected in the upper reaches of the rivers with abundant discharge in any of Negros, Panay and Luzon Islands, it will be necessary to construct dams on these rivers to ensure constant discharge throughout the year in consideration of the dry season which usually lasts 2 to 3 months.

For irrigation water, the use of surface water of the river is common, but the irrigation facilities observed during the survey were aimed mainly for rice field and it seemed that the irrigation of sugar-cane field was given less attention than rice field.

According to the report of the Philippine Sugar Institute 1964, irrigation is provided for 12.7 hrs or 10% of the total sugar-cane field extending over 126,143 hts. in Negros Island, a major sugar producing area. In other words, most of the sugar-cane fields depend mainly on natural rainfall for irrigation. The period in which the sugar-cane requires water most during its growing period is said to be 2—3 months after transplantation. Therefore, if that period falls on the rainy season, the growth of sugar-cane will be favorable. If transplantation is made during the dry season, on the contrary, supply of irrigation water is desirable.

On Negros Island the plain less than 20 m in elevation is dominated by rice field (double-cropping) studded with sugar-cane fields, but the highland over 20 m in elevation is used mostly for sugar-cane field.

For irrigation, the use of both the permanent irrigation method by means of concrete open canal and the mobile irrigation method which pumps up water from a nearby river and sprinkles water in the field with sprinklers attached to the vinyl tubes was observed.

In Panay Island the plans along the Jalaur, Panay and Aklan Rivers are dominated by rice field and the sugar-cane fields are seen only among the rice fields at rather high plains or in the tableland.

On the Jalaur River there is a dam 16 m in height at Moroboro which is situated in the midway between Barotac, Nuevo and Passi and a large scale irrigation canal is provided for the rice field in the plain on the right bank.

On the Aklan River there are a water gate on the right bank 14 km up Kalibo City to discharge water to the open canal at the rate of 7 m^3/s and an irrigation facility having a capacity of 5 m^3/s on the left bank.

As is known from the above, the river water used as irrigation water is mainly for rice field.

The power source of the sugar mills surveyed by the team was mainly by private power plant. The type of private power plant is steam turbine power plant using bagasse for fuel. Only the Canlubang Sugar Mill purchases from NPC 40% of its electric power requirement.

The quantity of process water used by a sugar mill is considerably large and the quantity of water taken from rivers by each sugar mill is shown in in the following table. Of the total quantity, approximately 10 to 15% may be considered to be used for boiler, potable water and other miscellaneous purposes, and furthermore, the water for the above purposes is treated before use. As most of the process water is used for cooling, the water is treated with a cooling device before use. For every ton of daily sugar-cane crushing capacity, 2–3 G/m (Approximately 3.8 ℓ/m = 1 G/m, 5.4 m^3 daily) of process water is required. Of the sugar mills surveyed, even the smallest mill has a daily sugar-cane crushing capacity of 3,000 t. requiring such a large quantity of process water as 35,000 t a day.

For this reason, it is an important factor for a sugar mill to be located in the site where abundant water is available.

Although the full use of these rivers for pulp and paper industry depends on the future development of the rivers, the existing pulp and paper industries are the Bais Sugar Mill (Daily pulp production of 35 t) which uses bagasse as raw material and takes water from the Tanjay River and the Rustan Pulp & Paper Mill (Daily production of 75 t of Lanan pulp by means of BKP method, 15 t of Abaca Pulp, 55 t of colugate medium, 105 t of white board) in Iligan City, Mindanao Island, which used Lauan and Manila hamp as raw material and gets water from the Agus River. A pulp and paper plant is also planned for the town of Bislig in the same island for the production of pulp by means of BKP method, RGP pulp, board and news prints from lauan. It was also felt that each sugar mill surveyed was keenly interested in the pulp and paper production with the use of baggase as raw material.

Process Water (River Water) of Sugar Mills

Name of Sugar mill	Location	Sugar-cane processing capacity MT/day	Quantity of process water (M^3/day)	Name of river supplying process water	Remarks
Canlubang	Luzon Island	6,000	6,000 (32,000)	Spring water	Water temp. 28°C
Batangas	"	3,500 ~4,000	16,000 (87,000)	Banabang	
Carebi	"	3,000	6,000 (32,000)	Bucao	Water temp. 31°C
Bais	Negros Oriental	4,500 ~4,900	15,000 (82,000)	Tanjay	Water temp. 29°C 3,500 G/m used for pulp process
Lopez	Negros Occidental	3,000 ~3,500	11,000 (60,000)	Himogaan	
Victorias	Negros Occidental	10,000	30,000 (160,000)	Malogo	
Ma-ao	Negros Occidental	4,111	24,000 (130,000)	Malacandan	Water rights for 24,000 on the tributary of the Bago River
Carlota	Negros Occidental	10,000	10,000 (54,000)	Najalin	
BISCOM	Negros Occidental	10,000	20,000 (108,000)	Binalbagan	Water rights for 20,000
Santos-Lopez	Panay Island	3,000	9,000 (49,000)	Jalaur	Water rights for 6,000. Pending for 3,000
Passi	Panay Island	4,500	32,000 (17,000)	Jalaur	

It is considered very likely that the pulp and paper industry will make a rapid progress in the Philippines in the near future.

1.1.4 Problem of Environment Pollution

The pollution caused by plant effluent may be classified into various types depending on the type of industry, extent of the use of water area and the location of plant discharge and therefore cannot be regarded uniform type. As the water plays an important role in every aspect of our daily life, even a slight change in the water basin will cause damages or dispute in various ways.

The extent of damage caused by water pollution varies depending on whether the priority in the use of water is given to potable water industry, irrigation, fisheries, tourism, navigation or recreation. Also, the damage to

domestic water, industrial water, agriculture, fisheries and environment sanitation appears and poses serious problems depending on the components of plant effluent. The extent of damage also varies depending on whether the plant is located in the coastal area or inland area or whether the plant discharge is made into the sea, bay, river estuary, river way or the lake.

In working out a plan for plant discharge, therefore, it is essential to make a careful study on various conditions including the quantity of plant discharge, changes in the quality of plant discharge, water quality in the water basin, river discharge, use of river, standard water quality, dilution of plant effluent after discharge and interference of other waste water. For the treat ment of plant effluent, the extent and the method of treatment should be determined after making a careful study on economic factors and the water quality.

Like in Japan, environment pollution makes headline of the newspaper every day in the Philippines and serious attention should be given to this problem.

Judging from the results of the recent survey, damages to marine products, such as blight or hindrance of growth of fishes and shellfishes, extinction of fresh-water weed, obstruction of spawning, death or hindrance of growth of fry, hindrance of immigration to upstream by river fish, and scattering of coastal fish are conceivable.

To cope with such a situation, construction of appropriate facilities at reasonable cost must be considered after making a careful study on the matter.

In designing plant facilities, the waste treatment facilities should be held to a minimum necessity.

It is advisable that full consultations are made with parties concerned on the matter so that the plant will not be forced into a position to remove even non-harmful substances from its waste water.

1.2 Groundwater Resources

It has already been known that the river water as a source of surface water is sufficient in quantity. Here the underflow water and groundwater will be discussed.

In principle the rain water always permeates the ground whenever there is a space underground. When the space becomes full of water the rain water comes out to the ground surface and flows down along the low ground. Therefore, the water flows in the river way only when there is water underground. To be more extreme, an excess of groundwater is the river water. Consequently, where there is a river there always is groundwater related with that river. Of the groundwater distributed widly and extending to the river bank, the water which gathers immediately beneath the river way through sand or gravels carried over by river water is the underflow water. The use of underflow water involves difficult problems and it cannot be said that the underflow water at any location is usable. The selection of underflow water is much influenced by the geology of river-bed and that at a depth of 10 m below the river-bed and by the changes of river-bed and bank. The survey shows that only the Bucao River, which was the only river condemned for use in the Philippines, has underflow water good for use as a water source.

The use of spring water or groundwater is the fastest, the most simple and economical way. It is also advantageous in that it supplies good quality water free of turbidity and changes in water temperature.

The groundwater consists of river water, canal water and permeating water which flow at the water level called the "ground-water table".

For this reason, this resources should be exploited to the maximum extent. The use of groundwater at the sugar mills surveyed is shown below.

Luzon Island:

Canlubang Sugar Mill
Three deep wells (1,000 ft. 700 ft and 600 ft in depth)
Quantity of water: 1,000 G/m, 1,000 G/m, 600 G/m = 2,600 G/m

Batangas Sugar Mill
Depth of well: 80 ft (Groundwater table - 15 ft)
Quantity of water: 2.5 m^3/M

Carebi Sugar Mill
Depth of well: 200 ft, 100 ft (two wells)
Quantity of water: 1,000 G/m

Negros Island:

Bais Sugar Mill
Groundwater is used to meet the total requirement of domestic water.

Lopez Sugar Mill:
Depth of well: 80 ft
Quantity of water: 150 G/m

Victorias Sugar Mill:
Depth of wells: 200~300 ft (several wells)
Quantity of domestic water: 500 G/m

Ma-ao Sugar Mill:
Depth of wells: 500 ft (Six wells)
Quantity of water: Large wells 600 G/m
Small wells 400 G/m
Total : 1,000 G/m

La Carlota Sugar Mill:
Depth of well: 600 ft, Diameter of tube: 8~12 inch
Quantity of water: 300 G/m

Binalbagan Sugar Mill:
Depth of well: 150 ft (Four wells)
Quantity of water: 700 G/m (Water level lowers 4-6 ft when pumping)

Panay Island:

Santos-Lozep Sugar Mill:
Depth of well: 150 ft (Three wells)
Quantity of water: 300 G/m

Passi Sugar Mill:

Total requirement for domestic water is met by well water.

The groundwater is used in these sugar mills for boiler water, domestic water and miscellaneous purposes in that order. In some mills where extra supply of water is available, the groundwater is used as cooling water.

For further exploitation of groundwater in the future, it is important to make a close study on the state of groundwater, including geology, groundwater table and groundwater aquifer.

As the approximate minimum discharge of each river is already known from the records which have been kept for years, it is necessary to secure the supply of groundwater in the amount equivalent to 30% of the total water requirement for a mill as an emergency measure to cope with the need in the dry season.

As for the water quality, both the river water and the groundwater in the Philippines contain silica in large quantity as in the case of Japan. In respect of agriculture, such a water quality brings about a better result on the growth of rice, but on the other hand, it becomes an obstruction when used as boiler feed water.

It will be necessary, therefore, to plan for the improvement of water quality depending on the purpose.

In any event, it will be necessary to make a careful study under the guidance of experts on the geology of the stratum, location of aquifer, location of wells, relations with other adjacent wells, friction loss of groundwater, optimum quantity of water to be pumped and to conduct water quality analyses and make selection of strainer and pipe material of appropriate types to ensure prolonged service life of wells and at the same time to reduce construction cost and maintenance cost.

CHAPTER 2. SUGAR CENTRALS

SECTION 2 SUGAR CENTRALS

2.1 General Description

The Republic of the Philippines is one of the top class sugar manufacturing countries in Southeast Asia and it produced approximately 1,900,000 tons of raw sugar in 1969 in its 38 sugar mills. Particularly, the sugar production in Negros Island accounts for 65% of the total production in that country.

Of the total sugar production, about 60% are exported to the United States under the Laurel-Langley Agreement and the remaining 40% are consumed in the country.

The target of sugar production and export under the Four-Year Development Plan is shown below and an annual growth of 4% is expected also in the future.

Supply and Demand of Raw Sugar

Source: Four-Year Development Plan

Year	Production (1) x 10^3 tons	Domestic demand (2) x 10^3 tons	Export (3) x 10^3 tons	Stock x 10^3 tons
1962	1468	494	1016	267
1963	1555	579	994	249
1964	1683	521	1061	350
1965	1557	460	1050	391
1966	1402	574	999	220
1967	1560	595	977	208
1968	1595	619	967	215
Prospects under Four-Year Development Plan				
1970	1735	670	1065	215
1971	1780	697	1085	215
1972	1870	725	1145	215
1973	1915	754	1161	215
1974	2015	784	1231	215

(1) Eight more sugar mills are expected to inaugurate operation in the 1970~1974 period.

(2) The annual growth rate of production in the past years is 4%.

(3) Exports as shown above are expected for the 1970~1974 period.

As the 38 sugar mills in the Philippines are located mainly in the three islands, namely, Luzon, Negros and Panay, as shown below, the recent survey covered those three islands and on-the-spot inspections were conducted in 12 sugar mills.

Number of Sugar Mills in Each Island

Island	Luzon	Negros	Panay	Cebu	Leyte	Mindanao	Total
No. of Sugar Mills	11	17	6	2	1	1	38
No. of mills surveyed	(3)	(6)	(2)	(0)	(0)	(0)	(12)

The sugar mills in Luzon Island scatter mostly in the central and southern parts and those in Negros Island concentrate on the Western and northern coasts, thus forming a sugar production belt. On Panay Island the sugar mills scatter on the upperreaches of the Jalaur River and the Panay River.

In general sugar mills belong to the Sugar Central and form communities with employee's housings and welfare facilities for the employees and their dependents. However, most of raw material sugar cane is purchased from the planters although some sugar-cane fields are owned by the Central. The payment of price of sugar cane is made at the rate determined according to the profit rate of the sugar mill.

As 60% of the total sugar production are exported to the United States in the form of raw sugar, the majority of the sugar mills in the Philippines are raw sugar producing mills and only the Carebi Sugar Mill (Luzon Island) and the Victorias Sugar Mill (Negros Island) are integrated refining sugar mills.

The capacity of these mills ranges from 3,000 tons to 10,000 tons/day (sugar cane milling capacity) and is 3,780 t/day on the average. The sugar mill having a 10,000 t/day capacity numbers three in Negros Island.

One of the outstanding features of the three new sugar mills surveyed by the team, namely, the Carebi, Batangas and Passi, is that the Diffuser System is employed in crushing process to improve the yield rate of sugar sap.

Sugar cane and sugar products are transported mainly by truck and private railway but the National Railway is laid only in and around Manila City and Panay Island and used only by part of sugar mills.

The raw sugar products for export are loaded on the barges at the pier and transported to Guimaras Island (Midway between Panay Island and Negros Island) before shipment to the United States.

The sugar mills generally operate from 7 to 8 months a year, but some of the mills in the northern part of Negros Island operate 11 months, which is an indication of considerable differences in the climate depending on the location. During these operating periods the mills hire seasonal laborers (accounting for 1/3 of the total labor force) to ensure continuous operation.

The weight of bagasse produced from sugar cane accounts for about 13% (bone dry weight) of the total weight of sugar cane processed, but most of the bagasse is used as fuel for boiler.

The excess bagasse (remainder of bagasse after being used for fuel) is piled up in open storage yard in bulk or in bail, or burned in special boilers in some sugar mills.

The bagasse boilers now in use are generally small and old in type and generate relatively low pressure steam for electric power generation.

The electric power demand is met completely by private power plant in almost all the sugar centrals. During the milling season, electric power is supplied by turbine generators and during off-season period, diesel generators are put into operation.

The companies which also operate pulp and paper mills in addition to sugar mills are the Canlubang Sugar Company and the Bais Sugar Company. The former uses abaca and the latter uses bagasse for raw material.

The Bais Pulp & Paper Mill is a typical integrated pulp and paper mill in the Philippines, which turns out 35 t/day of bagasse pulp and 45 t/day of high-grade papers with the use of excess bagasse produced in the parent sugar mill.

The production of excess bagasse varies greatly with each sugar mill. In each of the above two mills approximately 25% of the total bagasse production are excess and in most of other mills the production of excess bagasse accounts for less than 10% of the total bagasse production. However, with the improvements of combustion efficiency of boiler, thermal control and power source, each sugar mill is believed to have a capacity to increase the production rate of excess bagasse to over 22% without too much difficulty.

Particularly in the new factory, employment of a new plant will greatly improve combustion efficiency of the bagasse boilers with resultant increase in the production of excess bagasse. For this reason, effective utilization of bagasse will become one of the most important items of the future planning as part of diversification and rationalization of management.

Taking the production in 1969 for example, it is estimated that 2,820,000 t/year (bone dry) of bagasse was produced and the 22% of excess bagasse is equivalent to 670,000 t/y (bone dry).

2.2 Sugar Mills

2.2.1 Planning of On-the-Spot Survey of Sugar Mills

Prior to the start of filed survey, a preliminary survey was made on the location of the sugar central and its sugar mills to work out a survey schedule.

The purpose of this preliminary survey was to conduct on-the-spot surveys of the sugar central and obtain necessary data for the selection of a plant site for the construction of a bagasse pulp and paper mill as a mass industrial water consuming industry. The field survey program was worked out with a primary emphasis placed on the following points.

(1) State of sugar central in each island and factors related to the geography.

(2) State of major rivers as water resources and factors related to the the discharge of these rivers.

2.2.1.1 State of the Sugar Central in Each Island and Factors Related to the Geography

According to the statistical data on 30 major sugar mills (see Table 4) for the 1969—1970 crop year, 21,190,000 tons of sugar cane was processed and 1,900,000 tons of raw sugar was produced in the Philippines and the production of bagasse is estimated at 2,880,000 tons (bone dry).

There are a total of 38 sugar mills in the Philippines and the distribution of sugar centrals in each island is shown below.

Name of Island	Luzon	Negros	Panay	Cebu	Mindanao	Leyte	Total
No. of mills	11	17	6	2	1	1	38

For these sugar mills, a study was made on the following points.

(1) Determination of the area where a large quantity of bagasse may be collected without difficulty with due consideration given to the capacity and location of sugar mills in each island.

(2) Geographical relations with large consuming areas and the state of roads and ports in relation to the transportation of materials and products.

(3) State of the area around the sugar mills from the standpoint of industrial location.

(4) Other specific conditions

2.2.1.2 State of Major Rivers as Water Resources and Factors Related to the Discharge of These Rivers

This subject has already been discussed in detail in Part I, Water Resources. However, as the pulp and paper industry is a mass water consuming industry requiring a large quantity of process water and the availability of water is an important factor that decide the selection of industrial location, a study on the discharge of the major rivers must give careful consideration to the following points.

(1) That there is sufficient discharge (drainage area) of the major rivers throughout the year.

(2) Quality of river waters and the present use of the river, particularly the existence of irrigation facilities or fish ponds on the downstream.

(3) Other specific conditions

Division of the area and selection of the course of field survey were determined by taking into account the above factors and traffic situations in each area.

The area and the course of field survey were as follows:

No. 1 Central and southern district of Luzon Island

As Luzon Island is divided into north and south, each centering on two major consuming area, Manila Bay and the Great Manila, the following two survey courses were planned.

L-I course: South of Manila (Laguna de Bay and Batangas)

L-II course: North of Manila (San Fernando and Botolan)

No. 2 Iligan industrial area in Mindanao Island

A survey was conducted on the following related industries which have expanded with the back-up of rich water resources of the Agus River and favorable geographical location facing Iligan Bay.

M-I course: Lauan Pulp & Paper Mill

M-II course: Hydro electric power plants and chemical related plants along the Agus River

No. 3 Negros Island

Negros Island accounts for about 65% of the total sugar production in the Philippines and in the Negros Occidental sugar mills concentrate in the coastal area.

The following field survey program was worked out with Dumaguete in the Negros Oriental and Bacolod in the Negros Occidental using both cities as base camps.

N-I course: Dumaguete district (Bais)

N-II course: North of Bacolod City

N-III course: South of Bacolod City

No. 4 Panay Island

As the six sugar mills in Panay Island are distributed in the two areas, one on the upstream of the Jalaur River centering around Iloilo City and the other on the upstream of the Panay River centering around Roxas, the survey course was moved from Iloilo City to Karibo via Roxas.

P-I course: Upstream of the Jalaur River

P-II course: Panay River and Aclan River

2.2.2 Field Survey

The field survey was conducted from February 26 in the order of Luzon, Mindanao, Negros and Panay according to the planned courses, No. 1 to No. 4, mentioned in the previous section. Until the return to Manila on March 13, the survey was conducted for a period of 16 days.

During the survey period, camping was made in the following 8 cities, which were used as the base for the activities in the surrounding areas:

Manila (Luzon), Iligan (Mindanao), Dumaguete (Negros), Cebu (Cebu), Bacolodo (Negros), Iloilo, Roxas and Karibo (Panay)

For transportation between islands, boat was used between Negros and Panay and domestic flight was used for other islands. For land transportation, automobiles were used for the entire course except for the section between Iloilo City and Roxas in Panay Island where railway was used.

The sugar mills and major rivers surveyed are shown in Table I.

Table 1. Sugar Mills and Major Rivers Surveyed

No.	Date	Island	Plants surveyed	Rivers surveyed
1	Feb. 26	Luzon Is.	Canlubang Sugar Estate Batangas Sugar Central Inc.	Laguna de Bay Binambang River
2	Feb. 27	Luzon Is.	Central Azucarera Refinaria de Botaan Inc.	Bucao River
3	Feb. 28	Mindanao Is.	Maria Cristina Hydroelectric Power Plant	Agus River
4			Mabuhay Vinyl Plant	
5			Rustan Pulp & Paper Mill	
6	Mar. 3	Negros Is.	Central Azucarera de Bais	Tanjay River
7			Lopez Sugar Central Co., Inc.	Himogaan River
8			Victorias Milling Co., Inc.	Sicaba River Malihao River Malogo River
9	Mar. 6	Negros Is.	Ma-ao Sugar Central Co., Inc.	Bogo River
10			Central Azucarera de la Carlota	
11			Pulupandan Port	
12	Mar. 8	Negros Is.	Binalbagan-Isabela Sugar Co. Inc.	Binalbagan River
13			Sonthern Negros Dev. Co.	Ilog River
14			Hinigaran Port	
15	Mar. 10	Panay Is.	Central Santos-Lopez Co., Inc.	Jalaur River
16			Passi Sugar Central Inc.	
17			Malogo Irrigation Dam	
18	Mar. 12			Panay River
19				Aklan River
Total	16 days	Four Islands	12 sugar mills 2 sugar shipping ports 1 paper & pulp mill 2 correlated plants 3 hydro electric power plants 1 dam	One lake 14 rivers

Number of sugar mills surveyed:

Name of Island	Luzon		Negros			Panay		Total
Course	L-I,	L-II	N-I,	N-II,	N-III,	P-I,	P-II	(7 courses)
No. of mills	2	1	1	2	4	2	-	12

Because of the tight survey schedule, only two hours were allocated to each sugar mill for inspection. For this reason, a check list was prepared in advance to ensure efficiency in gathering necessary data. For the inspection of plant facilities, priority was given to the crushing process which has close relations with the production of bagasse, boilers and plant, water facilities and the source of water supply.

The findings of the survey of Iligan Industrial Area in Mindanao Island will be discussed in Section 6 "Chemicals Related to Pulp & Paper" and the findings of the survey on water resources, rivers and wells have already been discussed in Section 1 "Water Resources".

INQUIRY SHEET

NAME OF THE MILL

Name of the Island	Name of the Place	Name of the River	Date
1. RAW MATERIALS			
Volume of Sugar Cane			
Volume of Bagasse			
Period of Operation			
Disposal of Bagasse (Treatment)			
2. ELECTRIC POWER			
Source of Power			
Electric Pressure			
Cycle			
3. RIVER WATER			
Volume of the Water			
Quality of the Water			
Get-In System			
4. DEEP WELL			
Volume of the Water			
Quality of the Water			
Capacity of the Well			
Water Table			
5. LAND TRANSPORTATION			
6. SEA TRANSPORTATION			
Size of the Container			
Deepness of the Pier			
Difference of the Tide			
7. LABOR			
Number of Labors			
Working Hours			
Wages			
8. FIRM AREA			
Plantation Area			
Mill Area			
Quality of the Soil			
9. OTHERS			
Pollution Problem			

2.3 Survey Results of Sugar Mills

Of the 12 sugar mills surveyed by the team, the CAREBI and the Victorias are integrated sugar refining mills and the other 10 mills include representative plants in the Philippines although they are raw sugar manufacturing plants.

The BISCOM and the Victorias Sugar Mills are the largest in scale with a daily sugar cane milling capacity of more than 10,000 tons respectively and the latter has a record of the longest milling season (operating period) of 11 months.

In the three new sugar mills, namely, the Batangas, CAREBI and Passi, the Diffuser System is employed to ensure improvement of yield rate of sugar sap and besides, storage facilities of sugar cane and highly efficient boilers are provided.

Survey of the SONEDECO was cancelled as the plant was undergoing trial operation.

In the Lopez and La Carlota sugar mills sugar cane crushing facilities are being expanded and a complete shift from old system to new system is being planned.

It is regrettable that the team was unable to inspect the facilities of a typical bagasse pulp and paper mill (45 T/D in capacity), a branch of the Bais Sugar Mill (Negros Island), which employes the Pomilio System.

Data on the 12 sugar mills obtained through personal inerviews were summarized and shown in Table 3 and the statistical data on sugar cane and bagasse for 30 sugar mills provided by the Philippine Sugar Institute is shown in Table 4.

Table 3. LIST OF SUGAR MILLS SURVEYED BY THE TEAM (February 26 March 10, 1970)

No.		1	2	3	4	5	6	7	8	9	10	11
1	Name of sugar central (Abbreviation)	Canlubang Sugar Estate (CANLUBANG)	Batangas Sugar Central Inc. (BATANGAS)	Central Azucarera Refineria de Bataan Inc.(1) (CAREBI)	Central Azucarera de Bais (1) (BAIS)	Lopez Sugar Central Co. Inc. (LOPEZ)	Victorias Milling Co., Inc. (1) (VICTORIAS)	Ma-ao Sugar Central Co., Inc. (MA-AO)	Central Azucarera de la Carlota (LA CALOTA)	Binalbagan-Isabela Sugar Co., Inc. (BISCOM)	Central Santoz -Lopez Co., Inc. (SANTOZOLOPEZ)	Passi Sugar Central Inc. (1) (PASSI)
2	Acreage of operating area Yield of sugar cane Land owned by central Central's building lot	14,851 has 8,000 has (sugar cane 3,500 has) -	11,000 has - -	7,000 has 4,000 has 80 has	17,000 has - 30 has	13,000 has - 22 has	34,000 has 1,024 has (sugar cane - 750 has) 30 ~ 40 has	17,000 has - 42 has	22,000 ~ 26,000 has - 60 has	32,000 has - 60 has	9,015 has - 4 has (Mill site)	12,000 has Approximately 3,000 has -
3	Raw material· Sugar cane milling capacity(1) Achievement of sugar cane milling in '69 ~ '70 period Rate of bagasse content (Water content included) Production of green bagasse Use of bagasse Milling season	6,000 T/D 905,587 T 25% 238,222 T Fuel - 75% Nov.-Jul (8~9 months)	4,000 T/D (Real-3,500 T/D) 697,000 T]4% 72,997 T Fuel - 100% Dec.-Aug.(8~9 months)	3,000 T/D 58,000 T (under trial operation) 28 ~ 29 % 1,197 T Fuel - 100% (Heavy oil used as auxiliary) Oct.-May(7~8 months)	4,500 ~ 4,900 T/D 1,048,823 T 34.5% 340,332 T Fuel ≒ 75% Pulp produced from excess bagasse Jan.-Aug.(8~9 months)	3,000(1)~3,500 T/D (6,000 T/D expansion 643,000 T 25% 154,152 T Fuel - 75% Excess bagasse - 25% Nov.-Oct.(11 months)	10,000 T/D 2,375,000 T 27% 646,195 T Fuel - 100% Dec.-Nov.(nearly 12 m.)	4,111 ~ 4,400 T/D 738,852 T 25.5% 88,461 T Fuel 78% Excess bagasse 22% Sep.-May (8~9 months)	(1) 10,000 T/D (Real- 9,500 T/D) 1,266,000 T 25 ~ 30% 305,241 T Oct.-May (7~8 months)	Max. 10,000 T/D (Average - 8,500 T/D) 1,680,000 T 26% Sep -May (8~9 months)	Max. 3,000 T/D (Average - 2,800 T/D 455,269 T 26% 115,916 T Nov.-May (6~7 months)	Real - 4,000 T/D Under trial operation 26% 34,966 T Nov.-Sep.(10~11 months)
4	Power Power facilities: Type Turbine Diesel Power supply: Cycle Voltage	Purchased (NEC) 40% 2,000 KW turbine 60 480 V, 110 V	No purchase. Private power plant 3,100KW 3,200 KW turbine 60 440 V, 110 V	No purchase. Private power plant 3,250KW Two 1,500 KW turbines Two 2,000 KW diesel 60 4,160 V, 440 V, 220 V	No purchase. Two 1,000 KW turbines 1,440 KW diesel 60 480 V, 220 V	No purchase. 1,000 KW x 2, 1,500 KW turbine 1,000 KW, 400 KW diesel 60 480 V	No purchase. Private power plant - 3,750 KW 3,000 KW x 2, 500 KW turbine 60 440 V, 220 V, 110 V	No purchase 1,500 KW x 2, 1,000 KW turbine Three 750 KW diesel 60 440 V, 220 V, 110 V	No purchase. Private power plant - 3,000 KW 5,000 KW, 2,000 KW, 1,500 KW turbine Three 800 KW diesel 60 440 V, 220 V, 110 V	No purchase 2,500 KW x 2, 3,000 KW turbine Four 2,620 KW diesel 60 480 V, 220 V, 110 V	No purchase 1,500 KW, 500 KW turbine Five 405 KW diesel 60 440 V, 220 V, 110 V	No purchase 2,500 KW x 2 turbine Two 280 KW diesel 60 2,300 V, 440 V, 220 V,110 V
5	Water resources: Plant Water(2)· Source Quantity Intake method Deep well: Quantity Pump	Spring water 23 m^3/m (circulating system) Canal → Pump 10 m^3/m 3 pumps Depth. 1,000 ft, 700 ft. 600 ft	Binalbagan River 60 m^3/m Two 30m^3/m pumps - one 2.1 m^3/m pump Water level: 80 ft	Bucao River 23 m^3/m Canal → Pump - Three 1.1 m^3/m pumps Depth: 200 ft, 100 ft Water level: 30 ft	Tanjay River 57 m^3/m Canal → Pump (domestic water) - -	Himogaan River 42 m^3/m Pumpup - One 0.6 m^3/m pump Water level. 12 ft.	Malogo & Manihao River 115 m^3/m Pumpup (Domestic water) - -	Bago River - Pumpup 3.8 m^3/m 1.8 m^3/m, 1.1 m^3/m pumps Depth. 220 ft, 500 ft	Najalin River 38 m^3/m (circulation-150 m^3/m) Pumpup 0.8~1.2 m^3/m - Depth: 100 ft	Binalbagan River max. 76 m^3/m (circulating system) Canal (Four 2.7 m^3/m pump) - Three 2.7 m^3/m pumps Water level: 4~6 ft	Jalaur River 41.0 m^3/m Three 9.5 m^3/m and one 23 m^3/m pumps 0.6 m^3/m Three pumps Water level: 40 ft	Jalaur River 12 m^3/m (circulation-30 m^3/m) - - - -
6	Transportation: Product Freight charge(3) of sugar products	Box Car(Freight train truck . 10 ~ 30 ton loading capacity) → barge(1)→ Guimaras Island	7 ton truck (250) → (25 km)→Wawa Pier, barge → Guimaras Island Truck: 0.53¥/pickle	Truck→(46 km)→Masinloc Pier or→(70 km)→Sta. Cruz Pier, barge → Guimaras Island	Freight train and truck →(6 km)→Bolukas Pier, barge → Guimaras Is.	Freight train and truck→(mill compounds)→River, barge→Guimaras Is.	650 ton barge → Mauihao River →Guimaras Island	Freight train → Pulupandan Pier, barge → Guimaras Is. Sugar cane: 60~70 km 27¥/ton	Truck → Pulupandan Pier, 350 ton barge → Guimaras Island	Freight train→(15 km) →Hinigaran Pier, barge → Guimaras Island Truck: 15 km-0.5¥/ton	Truck→(32 km)→Iloilo Port, barge→ Guimaras Island Truck: 32 km - 0.74¥/pickle	Freight train (20%), truck (80%)→ (58 km)→Iloilo Port, barge → Guimaras Island (26 - 25 ton trailers)
7	Employees: Sugar mill	1,300, farm - 3,000 Abaca Pulp Mill - 150	500, transportation 400	1,000	2,000	600	2,800	1,254	1,200	1,600	540 (Seasonal laborer - 330)	368 transportation - 160
Remarks	(1) T = metric ton (2) 1 Gallon ≒ 3.8 (3) 1 Peso ≒ ¥56.00 1 Pickle = 63.25 kg 1/pickle ≒ 0.88 ¥/kg	(1) Island situated between Negros Island and Panay Island	(1) Diffuser system	(1) New integrated refining mill inaugurating this season (Diffuser system)	(1) Owns a bagasse pulp & paper mill (45 ~ 50 T/D). (2) Includes plant water 13 m^3/m for bagasse pulp & paper mill.	(1) After expansion the capacity will be increased to 6,000 T/D.	(1) Integrated refining sugar mill		(1) With the additional capacity of 7,000 T/D, the total capacity will be increased to 10,000 T/D.			(1) To be inaugurated this season. Under load test (Diffuser system)

Table 4. 1969 1970 Crop Year Sugar Central's Sugar Cane, Sugar & Bagasse

Source: Weekly Comparative Run Report

No.	Island	Sugar Central	(Abbreviation)	Mill Address	Capacity Tons Cane/ Year	Sugar Cane Ground Gross Tons	Raw Sugar		Green Bagasse			Bon Dry - Bagasse		Remarks Column
							Tons	% Gross Cane	% Gross Cane	% Polarization	% Moisture	% Gross Cane	Tons (B.D.)	
1	Luzon	Canlubang Sugar Estate	(Canlubang)	Canlubang	6,000	905,587	105,455	11.64	26.3	4.2	48.9	13.5	121,703	Abaca Pulp Plant (15 T/D)
2		Pampanga Sugar Mills	(Del Carmen)	Del Carmen	6,000	610,035	54,206	8.92	26.2	3.8	49.0	13.4	81,559	
3		Central Azucarera Don Pedro	Don Pedro)	Batangas	4,800	526,295	52,120	9.90	25.4	3.9	48.6	13.1	68,709	Diffusion System
4		Hind Sugar Mills Inc.	(Hind)	Man-aog	530	75,093	6,200	8.26	24.4	4.2	48.5	12.5	9,435	
5		Pampanga Sugar Dev. Co., Inc.	(PASUDECO)	San Fernando	6,500	770,887	63,908	8.29	26.7	3.4	49.2	13.6	104,559	
6		Central Azucarera de Tarlac.	(Tarlac)	San Miguel		959,705	75,710	7.90	29.6	3.1	52.5	14.1	135,191	
7		Batangas Sugar Central, Inc.	(Batangas)	Balayan	4,000	257,485	27,727	10.77	28.3	2.3	52.0	14.0	34,976	Diffusion System, Refining Integrated Mill
8		Central Azucarera Refineria de Bataan	(CAREBI)	San Juaer, Botolan	3,000									
9		Paniqui Sugar Mills, Inc.	(Paniqui)	Paniqui, Tarlac	1,500	210,096	17,301	8.23	27.8	4.5	48.2	14.4	30,254	Alcohol Plant
10		San Mariano Development Corp.		Milapia	(750)									
11		Central Azucarera de Bamban		Bamban	(1,050)									
12		Sub-total				4,315,183	402,627	9.24	26.8	3.7	49.6	13.6	586,385	
13	Negros	Bacolod-Murcia Milling Co., Inc.	(Bacolod)	Bocolod	3,500	543,451	52,782	4.68	26.5	3.7	49.3	13.5	73,015	
14		Central Azucarera de Bais	(Bais)	Bais Central	3,500	1,047,823	86,081	8.22	32.5	3.3	49.8	16.3	170,952	Bagasse Pulp Paper Mill (45 T/D)
15		Binalbagan-Isabela Sugar Co., Inc.	(BISCOM)	Binalbagan	10,615	1,683,410	149,469	8.92	23.6	3.8	48.7	12.0	202,581	Alcohol Plant
16		Danao Development Corporation	(Danao)	Toboso	2,099	426,193	33,933	7.96	27.7	3.6	50.9	13.6	57,965	
17		Hawaiian-Philippine Company	(Hawaiian Phil.)	Silay-Hawaiian Central	6,200	1,130,071	113,812	10.07	27.4	3.2	50.5	13.6	153,270	
18		Central Azucarera de la Carlota	(La Carlota)	La Carlota		1,266,034	112,084	8.85	24.1	3.5	50.2	12.0	151,946	
19		Lopez Sugar Central Co., Inc.	(Lopez)	Fabrica	3,500	643,455	51,262	7.98	24.0	4.1	50.0	12.0	77,214	
20		Ma-ao Sugar Central Co., Inc.	(Ma-ao)	Bago	4,111	738,882	75,811	10.27	26.0	3.9	49.0	13.3	97,975	
21		San Carlos Milling Company, Inc.	(San Carlos)	San Carlos	4,800	905,936	80,859	8.93	27.0	3.2	49.7	13.6	123,034	
22		Talisy-Silay Industrial Coop., Assn.	(Talisy-Silay)	Talisay	3,616	605,589	55,386	9.11	25.0	3.8	49.1	12.7	77,067	
23		Victorias Milling Company, Inc.	(Victorias)	Bacolod	10,000	2,375,377	212,612	8.97	27.2	2.1	48.9	13.9	330,158	Refining Integrated Mill
24		First Farmers Milling a Marketing Coop. Assn., Inc.	(First Farmer)	Talisay	3,490	795,950	79,957	10.05	27.6	2.9	52.0	13.3	105,446	
25		Agro Industrial Dev. Co., of Silay-Saravia, Inc.	(AIDSISA)	Silay	3,000	585,623	54,388	9.29	29.0	2.2	50.7	14.3	83,726	
26		Sagay Sugar Central, Inc.	(Sagay)	Bobato, Sagay	3,000	613,184	48,931	8.01	26.1	3.0	50.8	12.8	78,739	
27		Southern Negros Dev. Corp.	(SONEDCO)	Kabankalan	4,000	209,006	19,727	9.49	28.3	2.3	50.7	14.0	29,159	
28		Docong-Cogan Sugar & Rice Milling Co., Inc.		Tobugon	1,500									
29		Tolong Sugar Milling Co., Inc.		Sta Catalina	3,000									
30		Sub-total				13,569,984	1,227,094	8.72	26.8	3.2	50.0	13.4	1,812,241	
31	Panay	Asturias Sugar Central Inc.	(Asturias)	San Juan, Dumalag	2,000	428,536	35,553	8.3	23.2	3.5	50.5	11.5	49,212	
32		Central Azucarera de Pilar	(Pilar)	Roxas	2,618	724,050	53,981	7.46	24.6	3.4	49.3	12.5	90,304	
33		Central Santos-Lopez Co., Inc.	(Santos-Lopez)	Balotack	2,678	455,269	43,693	9	25.5	4.3	49.11	12.8	58,394	Alcohol Plant
34		Calinog-Lumfunao Sugar Mill Integrated Farming Inc.		Calinog	4,000	228,174	21,351	9.36	29.0	2.4	52.0	13.9	31,761	
35		New Frontier Sugar Corporation	(New Frontier)	Passi	5,500									
36		Passi Sugar Central Inc.	(Passi)	San Enrique	4,000	128,417	10,348	8.06	27.2	3.1	49.8	13.7	17,533	
37		Sub-total				1,964,446	164,926	8.56	25.9	3.3	50.2	12.9	247,204	
38	Cebu	Bogo-Medellin Milling Co., Inc.	(Bogo)	Medellin	2,500	381,662	34,349	9.00	25.6	3.2	48.3	13.2	50,551	
39		Durano Sugar Mills	(Durano)	Dungo-an	2,000									
40		Sub-total												
41	Leyte	Ormoe Sugar Company, Inc.	(Ormoe)	Ipil Ormoe	2,500	965,096(+α)	76,480(+α)	7.92	26.7	3.4	51.8	12.9	124,201(+α)	
42	Mindanao	Mindanao Sugar Development Corporation												
43	Total				3,767 T/D	21,196,371	1,905,476	8.69	26.4	3.4	50.0	13.2	2,820,582	

2.3.1 Size of Sugar Central

The sugar central is equipped with employees housing, welfare facilities and a school building to form a mill compound and is surrounded by a vast sugar cane field.

The milling districts of this sugar cane field are owned mostly by planters who supply the sugar mill with sugar cane and get their shares in the profit.

The sugar mill itself also owns land equivalent to 20 to 40% of the total milling district for cultivation of sugar cane.

Although per ha yield of sugar cane varies greatly with each area, the average yield is 60 t/ha.

2.3.2 Raw Material· Sugar Cane

2.3.2.1 Sugar Cane Milling Capacity

The capacity of a sugar mill is generally expressed by the milling capacity (Metric tons/day) for a day after removing leaves and roots of sugar cane at the field.

The capacities of sugar mills range generally from 750 T/D to 10,000 T/D maximum and is 3,780 T/D on the average. The milling facility is generally composed of 2 to 5 lines and the largest line has a capacity of 6,000 T/D.

2.3.2.2 Annual Milling Capacity

The amount of annual sugar cane milling for a sugar mill is the amount handled during the crop year and is generally proportionate to the product of the installed milling capacity and the length of milling season, though the latter may vary with each area.

According to the statistical data shown in Table 4, the amount of annual milling of sugar cane in each island in the 1969 1970 crop year is as shown below and the production in Negros Island accounts for about 65% of the total production.

The amount of annual sugar cane milling for a sugar mill is the amount handled during the crop year and is generally proportionate to the product of the installed milling capacity and the length of milling season, though the latter may vary with each area.

According to the statistical data shown in Table 4, the amount of annual milling of sugar cane in each island in the 1969—1970 crop year is as shown below and the production in Negros Island accounts for about 65% of the total production.

Amount of Sugar Cane Milling in Each Island (1969—1970 Crop Year)

Name of Island	Luzon	Negros	Panay	Others	Total
No. of mills	8	15	5	2	30
Amount (10,000 T/Year)	4,31.5	13,57.0	1,96.4	1,34.6	21,19.6
%	20	64	9	6	100

2.3.2.3 Production of Bagasse

The sugar cane transported to the sugar mill is milled in the crushing room and the sugar sap thus obtained is processed into sugar.

The strained draff has a water content of about 50% and is simply called green bagasse and used mainly as fuel for the boilers.

The bagasse is directly transported to the boiler room by conveyor and most of it is burned in the boiler. The excess bagasse (the remainder), is stored in bulk or compressed in bails for storage.

The rate of green bagasse with a water content of about 50% produced in the crushing room ranges from 24 to 34.5% of raw sugar cane. Factors of variation are considered to be the variety, process of growth and harvesting time of sugar cane.

In the Bais Sugar Mill which also manufactures bagasse pulp from excess bagasse, the rate of green bagasse is 34.5% at the maximum or 345 kg (Water content being 49.8%) per ton of sugar cane.

2.3.2.4 Milling Season of Sugar Mills

In general the sugar mill is classified into two types. One is the raw sugar mill which produces crude sugar and the other is the refining integrated sugar mill which refines raw sugar into refined sugar. The former operates only during the harvesting period and stays idle for the rest of the year and the latter generally operate continuously throughout the year.

Although the milling season of a raw sugar mill almost coincides with the harveting season of sugar cane, each has a different meaning in a strict sense.

According to the results of a survey, the milling seasons for the 12 sugar mills vary as follows depending on the area or course of the survey.

Milling Seasons for Sugar Mills in Each District

(1) Island	Luzon		Negros			Panay
(2) Survey course	L-I,	L-II,	N-I,	N-II,	N-III,	P-I
(3) No. of mills	2	1	1	2	3	2
(4) Milling season	Nov.-Jul. Dec.-Aug.	Oct.-May	Jan.-Jul.	Nov.-Oct. Dec.-Nov.	Sep.-May Oct.-May Sep.-May	Oct.-May Nov.-May
(5) Milling period	8~9 months	7~8 months	7~8 months	Over 11 months	8~9 months	6~8 months

The area with the longest milling season is the northern part of Negros Island (N-II course) where continuous milling through the year is reported to be possible.

2.3.2.5 Electric Power Supply

The electric power demand in the sugar central (Sugar Mills) is met mostly by private power plant and self-sufficiency in power supply is maintained.

The power is supplied mainly in 400 V, 60 cycle and three-phase at the transmission end and the operating voltages are 400 V, 200 V, and 100 V. Turbine generator is used during the milling season while diesel generator is used during the off-season.

At the BISCOM sugar mill with a sugar cane milling capacity of 10,000 T/D, two 2,500 KW turbine generators were in operation and the load was approximately 3,500 KW. At the new sugar mills the motive power for the crushing equipment is being changed from the existing steam engine to turbine or motor, which is a sign of efficiency improvement of motive power.

The input steam pressure of turbine is comparatively low being 8–35 kg/cm^2 and the average is about 17 kg/cm^2.

The back steam pressure is about 1 kg/cm^2 and it is used as heating steam in the evaporators or pans.

The power consumption per ton of sugar cane varies with each sugar mill but the average power consumption is about 8 KwH.

2.3.2.6 Boiler

The boiler installed at the sugar mill is the bagasse boiler which uses bagasses as fuel and is equipped with an auxiliary heavy oil burner. Because of the small capacity, low pressure and simple design of furnace, the thermal efficiency of the boiler is estimated at 60 – 65%.

With the new type boilers installed in the new sugar mills or expanded mills, however, the centralized instrument panel system is employed and 75% or more of thermal efficiency of boiler is expected.

The basic unit of steam for the production of raw sugar is 0.5 0.6 kg/ton cane. The type of steam is the saturated steam and boiler pressure at each mill is as follows.

Steam Pressure at Each Mill

Mills	Bais	La Carlota	Passi	Batangas	Lopez	BISCOM	Santos Lopez	Ma-ao	Average
Pressure (kg/cm^2)	35	32	26	20	11.5	10.5	9	8	17

Heavy oil is used as auxiliary fuel for firing boilers at the start of operation or at the time of suspension of the program and for irregular services such as changes in load. The amount of heavy oil consumption varies with each mill but is generally believed to be less than 0.1% of the amount of sugar cane.

2.3.2.7 Plant Water

The plant water of the sugar mill is used mostly for cooling in the concentration process of sugar sap and for such other purposes as boiler feed water and domestic water.

For plant water, all sugar mills, except the Canlubang Sugar Mill where spring water is used, take river water which is pumped from intake points to the mill.

The process water is used at the rate of 14 15 m^3 per ton of sugar cane and part of the process water is recovered, cooled and reused in most cases.

Well water is used in all sugar mills mainly for boiler feed water and domestic water.

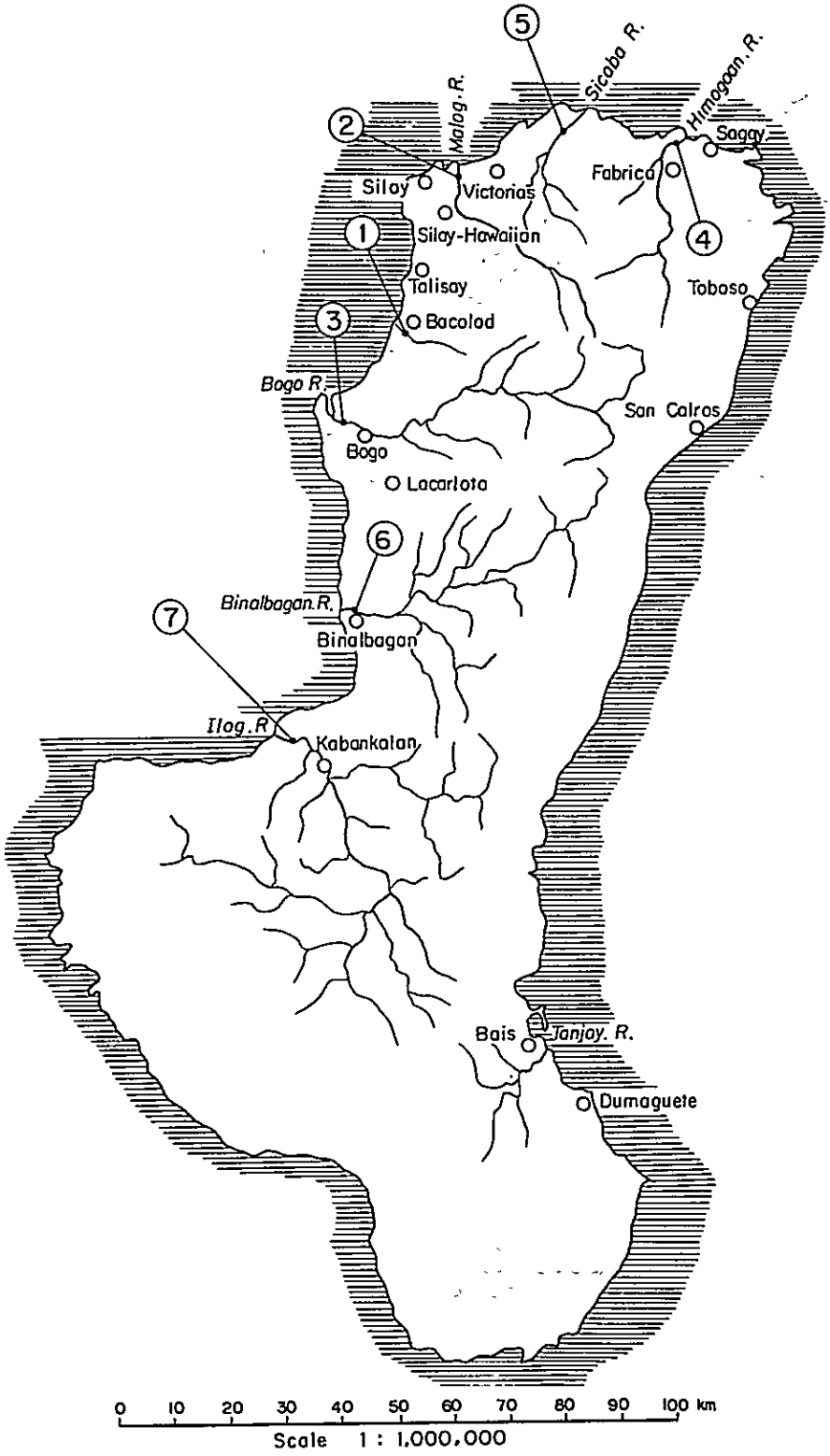
To check the quality of river waters for major rivers, sampling was taken at each river and analyses were made with a portable water quality analyzer on seven items, namely, pH, hardness, chlorine, P & M alkalinity and SO_3. The results of analyses are shown in Table 5 and sampling points are indicated in Fig. 1 and 2. Although the waters of these rivers are generally acceptable as process water for pulp and paper industry, the water of some rivers shows a high grade of hardness, M and alkalinity and a sign of chlorine. For this reason, a careful study must be made before decision is made on the use of river water.

Table 5. Analysis of River Waters For Major Rivers

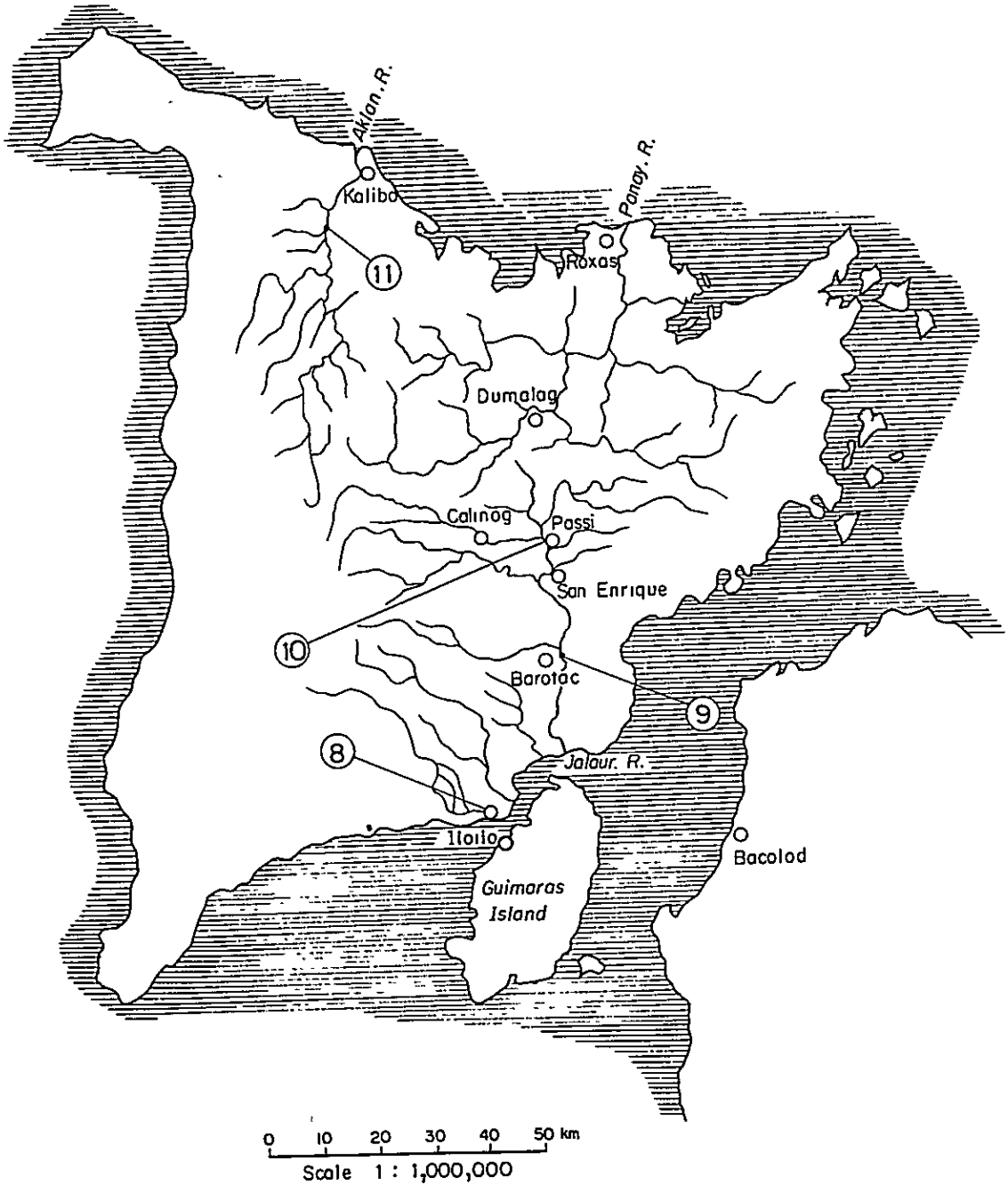
No	Items Analyzed \ Sampling point	(1) BACOLOD CITY	(2) MALOGO	(3) BAGO	(4) HIMOGAAN	(5) SICABA	(6) BINALBAGAN	(7) ILOG	(8) ILOILO CITY	JALAUR (9) SANTOS-LOPES	(10) PASSI	(11) AKIAN
1	P : H	6.6	6.6	6.8	6.4	6.8	6.8	7.8	6.8	6.8	6.4	6.6
2	Total alkalinity·PPM calculated by $CaCO_3$	104.0	37.0	51.0	24.0	23.0	156.0	204.0	192.0	212.0	150.0	46.0
3	Chlorine Ion · PPM	8.0	8.0	6.0	8.5	6.5	17.0	72.0	15.0	100.0	80.0	4.0
4	Total hardness:PPM calculated by $CaCO_3$	174.0	34.0	56.0	30.0	30.0	116.0	164.0	200.0	232.0	162.0	50.0
	P·Alkalinity	0	0	0	0	0	0	0	0	0	0	0
	M·Alkalinity	174.0	34.0	56.0	30.0	30.0	116.0	164.0	200.0	232.0	162.0	50.0
5	Sulphite Ion PPM	3.0	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil(1.0)
6	Date of sampling	March 7 5:30PM	Mar. 5 5:15PM	Mar. 6 9:00AM	Mar. 5 1:00PM	Mar. 5 2:40PM	Mar. 8 9:30AM	Mar. 8 2:50PM	Mar. 10 7:10PM	Mar. 10 9:30AM	Mar. 10 4:30PM	Mar. 12 3:30PM

Source : Survey Mission
Analyzer: Kurita Water Quality Analyzer (TA-1)

Annex Fig. 1 Map of Negros Island with Major Rivers
(Sampling Stations)



Annex Fig.2 Map of Panay Island with Major Rivers



2.3.2.8 Transportation

Although the cargo item transported to and from sugar mill includes sugar cane as raw material and sugar and molasses as products, the sugar cane accounts for 70—80% of the total cargo in respect of volume. The raw sugar for export, 60% of total production is exported to the United States, is collected at Guimaras situated between Negros Island and Panay Island by barge (300~350 tons) before shipment.

For inland transportation, national railway, private railway and trucks are used. The National Railway has three lines, one in the north of Manila City, one in the south of the city and one between Iloilo and Roxas in Panay Island. Only the Canlubang and PASUDECO Sugar Mills in Luzon Island and those in Panay Island use the National Railway. Other mills rely on their own railway or truck and some mills totally rely on truck for transportation.

For the transportation of sugar cane, trucks (7 10 ton) are actively used and sugar cane is transported from a distance of 50 60 km from the mill. Scores of trucks fully loaded with sugar cane are seen in queues at the entrance of the mill awaiting their turn.

The raw sugar for export, the main product, is transported to the shipping port of the island in bulk by private freight car or by truck. In Negros Island there are the shipping port of Pulupandan jointly owned by three sugar mills (Ma-ao, Silay and Barolod-Muria sugar mills) and the port of Hinigaran owned by BISCOM Sugar Mill.

These shipping ports are equipped with heavy oil storage tanks.

2.3.2.9 Labor Force

As the sugar mill operates for 7 to 8 months and stay idle for the rest of the year, the type of employment by sugar mills is classified into two categories. One is the seasonal laborers (non-regular employees) who engage in the work only during the milling season and the regular employees who engage in repair and maintenance of equipment even during the off-season period. The number of seasonal laborers is said to account for more than 1/3 of the total labor force of a sugar mill. Besides, there are farm workers who engage in cultivation of sugar cane at the plant farms and for this reason, the number of employees fluctuates with the season.

During the milling season the plant operates continuously and the employees work on three shifts.

As for the wage, the Minimum Wage Law is in effect and the wage is determined in each locality. Various allowances are added to the basic wage to make a reasonable wage structure.

2.3.2.10 Profit-sharing in Sugar Production

The relationship between the sugar cane planters and the sugar central (sugar mill) is that the former supply sugar cane and the latter manufactures sugar from it and sell the products.

For the distribution of profits which is a fruit of the cooperation between the two parties, there has been an agreement between the sugar central and individual sugar cane planters on the profit-sharing for the sugar or molasses and the rate of sharing is also diversified.

The question of profit-sharing will become an issue which must be solved by mutual agreement between the two parties when the bagasse shows a high monetary value as a result of its use as raw material of pulp or when the fuel of boiler is changed from bagasse to heavy oil in the future.

Appropriate solution to such a problem is one of the important factors for materializing pulp production from bagasse. It was a rich harvest to the team that it was able to obtain some information on this matter.

2.3.2.11 Pollution Problems

The environment pollution caused by a sugar mill generally includes air pollution as a result of ashes contained in the smoke emitted from the bagasse boiler and water pollution as a result of discharge of bagasse, sugar sap or dregs contained in the plant waste water or the rise of water temperature. In the Philippines appropriate counter-measures are being taken against each possible source of environment pollution and it seems no big complaints have been raised about this problem.

As a measure to prevent air pollution by emission from the boiler, a dust collector is installed in the chimney flue and for the prevention of water pollution, the plant waste water is discharged to such safe zones downstreams or the estuary of the river by means of lagoon or specially built drainage canals.

2.4 Quantities of Excess Bagasse

2.4.1 Amount of Bagasse Production

The strained draft of sugar cane produced in the crushing process of the sugar mill has a water content of about 50%.

According to the statistical data contained in Table 4, the sugar cane production and estimated bagasse production in 30 sugar mills in the Philippines are as follows:

Sugar Cane Production and Estimated Bagasse Production

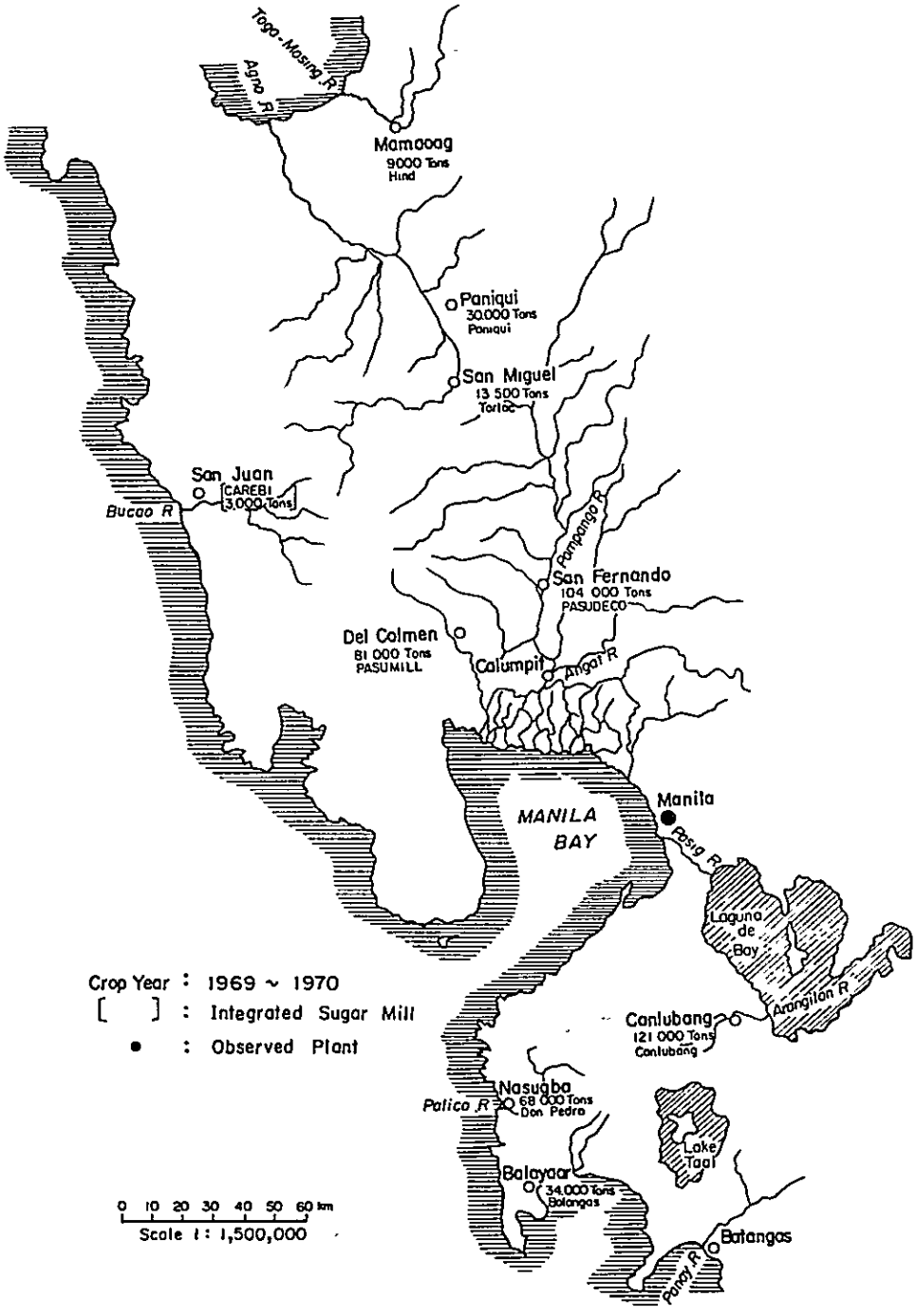
1969—1970 Crop Year

No.	Name of Island (Name of Sugar Mills)	Sugar Cane 10,000 T/Year	Bagasse Production (Bone dry)	Bone Dry Bagasse 10,000 T/Year
1	Luzon (8)	431.5 (20.4%)	13.6%	58.6 (20.8%)
2	Negros (15)	1,356.9 (64.0%)	13.4%	181.6 (64.0%)
3	Panay (5)	196.4 (9.3%)	12.9%	24.7 (8.9%)
4	Cebu (1)	38.2 (1.8%)	13.4%	5.1 (1.9%)
5	Leyte (1)	96.5 (4.5%)	12.9%	12.4 (4.4%)
6	Total (30)	2,119.6 (100%)	13.2%	282.1 (100%)

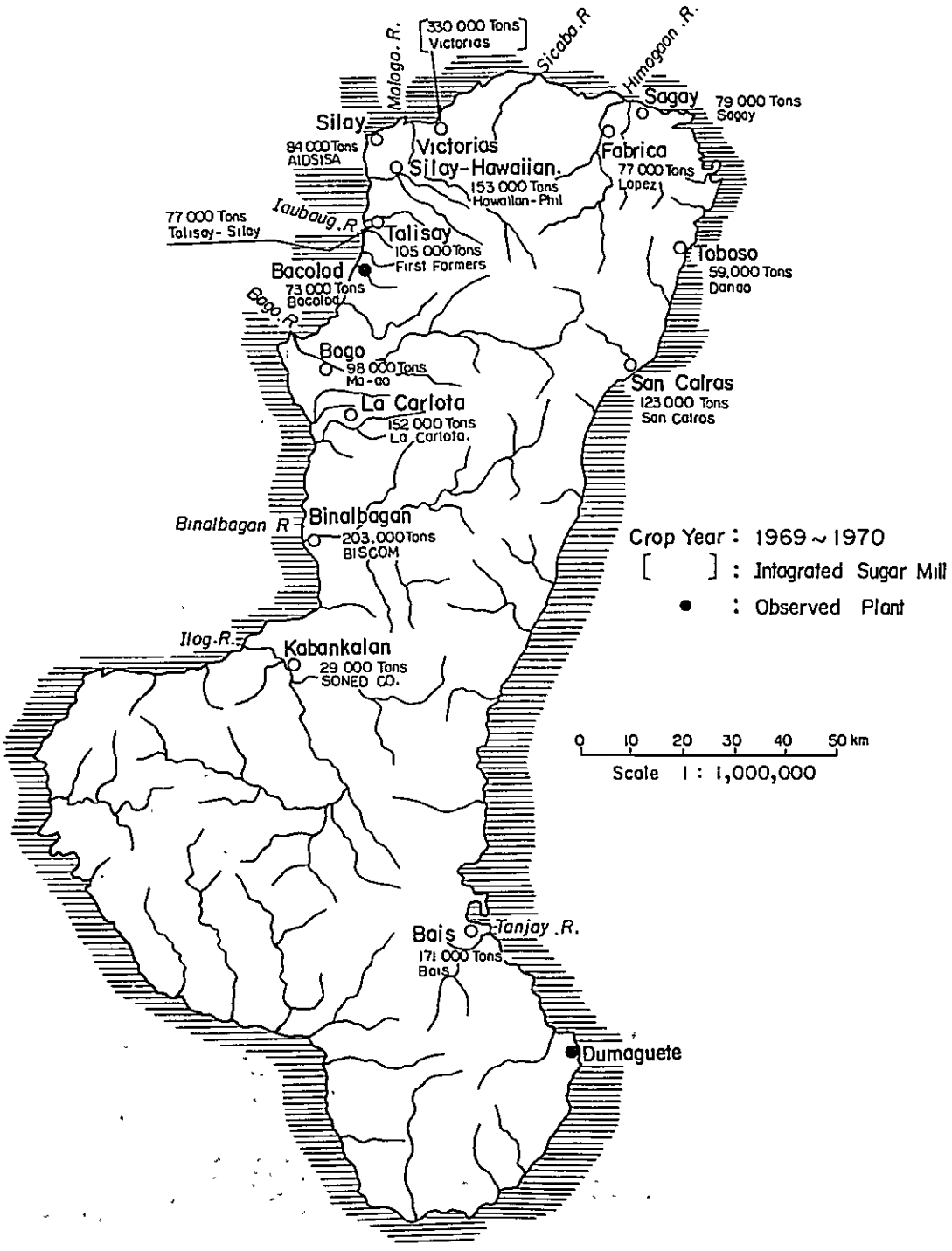
Source: Weekly Comparative Run Report

The locations of sugar mills and the distribution of bagasse production are shown in Fig. 3, 4 and 5.

Annex Fig. 3 Distribution Map of Sugar Mills and the Estimated Amount of Dry Baggase in the Central and Sonthern Luzon

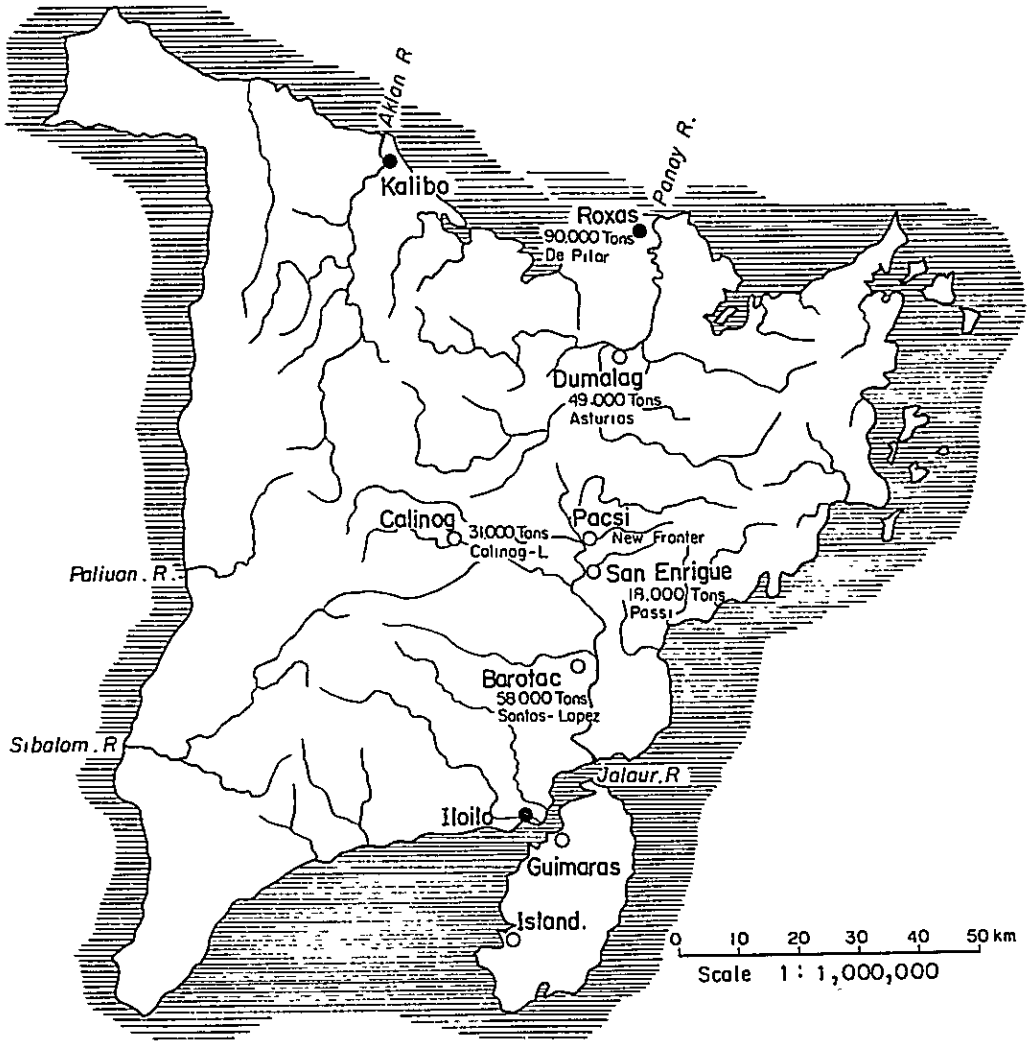


Annex Fig.4 Distribution Map of Sugar Mills and the Estimated Amount of Dry Baggase in Negros Island



Annex Fig. 5 Distribution Map of Sugar Mills and the Estimated Amount of Dry Baggase in Panay Island.

Crop Year : 1969 ~ 1970
● : Observed Plant



Bagasse production in Negros Island accounts for about 65% of the total bagasse production in the Philippines and concentrates in the Occidental Province.

The yield of sugar cane is generally said to be 60 tons per ha. The yield rate of raw sugar is 9% and that of bagasse (water content of 50%) is about 27%. 2,820,000 tons of bagasse (BD) is equivalent to about 1,000,000 tons of heavy oil and could serve as effective fuel material.

The bagasse production and annual growth rate in production for each island in the 1965—1969 period are estimated as shown in the table below. Against the average annual growth rate of 1.08, the rate for Negros is 1.12 and that for Panay Island is 1.19.

As the demand for sugar is growing steadily both at home and abroad, the production of bagasse is expected to expand along with the growth of sugar production in the future.

Table 3. Sugar Cane Production in the Philippines and Growth Rate

No.	Island	Number of Sugar Mills	Item	1965 - 1966	1966 - 1967	1967 - 1968	1968 - 1969	1969 - 1970	Ave.
1	Luzon	9	Prod. $\times 10^3$ T/Y	905	957	977	994	1,167	
			Rate %		1.03	1.01	1.01	1.13	1.04
2	Negros	15	Prod. $\times 10^3$ T/Y	2,214	2,542	2,626	2,799	3,566	
			Rate %		1.14	1.04	1.07	1.27	1.12
3	Panay	6	Prod. $\times 10^3$ T/Y	694	694	776	967	1,376	
			Rate %		1.0	1.11	1.24	142	1.19
4	Cebu	2	Prod. $\times 10^3$ T/Y	73	87	90	76	98	
			Rate %		1.19	1.04	1.45	128	1.07
5	Leyte	1	Prod. $\times 10^3$ T/Y	66	105	60	153	257	
			Rate %		159	0.57	2.52	1.68	1.41
6	Total	33	Prod. $\times 10^3$ T/Y	3,952	4,385	4,125	4,900	5,464	
			Rate %		1.17	0.94	121	110	1.08

1) Water content of sugar cane is to be 50%.

2) Source of basic data: Forest Product Research & Industrial Development Commission

2.5 Situation of Excess Bagasse

The sugar cane bagasse left as a remainder of fuel for the boiler is generally called excess bagasse. In actuality, however, the bagasse is used also as fuel for locomotives of freight trains transporting sugar cane or for fertilizer in some mills though only in a small quantity.

The ratio of excess bagasse to the total bagasse production in the 12 sugar mills surveyed is shown in the table below. Of the sugar mills listed in the table, two are the integrated refining sugar mills and use only the bagasse as fuel for the boilers. Two of the 12 mills are new mills and were under trial operation with the use of the Diffuser System. Accordingly, no information was available. However, as the Diffusion System requires heating of sugar cane, consumption of fuel for the boiler is expected to increase accordingly.

Ratio of Bagasse Consumption in Sugar Mills Surveyed

No.	Ratio of Boiler fuel (%)	Ratio of excess bagasse (%)	Number of mills
1	100%	0%	3 (2 integrated refining sugar mills)
2	75～78%	(25～22%)	4 (2 in Negros, 2 in Luzon)
3	91～95%	9～5%	3 (2 in Negros, 2 in Panay)
4	Unknown	Unknown	2 (2 new mills)

As shown in the above table, the ratio of excess bagasse varies greatly ranging from 5% to 25%. The two sugar mills for which the ratio of excess bagasse is 25% are the Bais Sugar Mill (Negros Island) which produces bagasse pulp and paper and the Canlubang Sugar Mill (Luzon Island) which is under planning stage. The low ratio for other sugar mills is attributable to the lack of necessity for use of excess bagasse as no definite plans for its use have been worked out by them.

2.6 Calculation of Calorific Value of Bagasse

On the basis of available data, an attempt is to be made to calculate calorific value of bagasse in each sugar mill so that the present use of the bagasse may be indicated by figures for forecasting the future status of excess bagasse.

By comparing the basic unit of electric power and steam in the production of sugar against theoretical value of electric power and steam which may be obtained through calculation of calorific value, the availability of excess bagasse in the future may be estimated. The process of electric power and steam generated in the bagasse boiler is led to turbine generator for electric power generation and the back steam of the turbine is utilized for the manufacturing process.

(1) Basic unit of electric power and steam in the production of crude sugar

By using the data obtained in the BISCOM and the La Carlota Sugar Mills as the basic unit in the production, the following mean values are to be adopted.

Basic Unit of Power and Steam in the Production of Raw Sugar

	Steam Tons/Ton cane	Electric Power KWH/Ton cane
A Company	0.54 ～ 0.68	5.2～8.5
B Company	0.59	8.6～8.8
Average	0.60	8.0

(2) Calorific value of green bagasse (50% water content)

From the analytical value of green bagasse, the calorific value may be calculated by the following equation.

With the use of the mean value shown in the statistical data in Table 4 as analytical value, the effective calorific value of green bagasse may be calculated as follows:

Calorific value = (4750 F + 3955 S + 3750 G - 540W) ÷ 100 ≒ 2078 K cal/kg

where: S : Sugar % = 3.3%
G : Reducing sugar ≒ Assumed to be 0%
W: Water content = 50%
F : Fiber % = 100 - S - G - W = 46.7%

(3) Ratio of green bagasse production

From the statistical data in Table 4 the mean values of green bagasse production per ton of sugar cane and of water content are to be used.

Green bagasse production:	269 kg/ton cane
Water content:	50%

(4) Boiler steam generating capacity per ton of sugar cane

The type of steam generated by the bagasse boiler is to be the saturated steam with the mean value of 17 kg/cm^2 (i = 668 K cal/kg) discussed in 3.2.6.

With the thermal efficiency of 65% which was estimated in 3.2.6 and the estimated feed water temperature of 60°C, the volume of steam that can be generated by one ton of sugar cane may be calculated as follows.

$$\text{Steam generating capacity} = \frac{2078 \text{ K cal/kg} \times 0.269 \text{ ton/ton cane} \times 65\%}{(666.8 \text{ K cal/kg} - 60°\text{C}) \times 100}$$

$$= 0.60 \text{ ton/ton cane}$$

(5) Electric power generating capacity of turbine by per ton of sugar cane

The volume of input steam of turbine generator is assumed to be the volume of generated steam described in the previous paragraph (4) and the back steam pressure is assumed to be 1 kg/cm^2 saturated steam (i = 646.5 K cal/kg).

By assuming the electric power generating efficiency is 75%, the power energy generated by one ton of sugar cane may be calculated as follows:

Electric power generating capacity

$$= \frac{600 \text{ kg/ton cane} \times (666.8 - 646.5) \text{ K cal/kg} \times 75\%}{860 \text{ K cal/KWH} \times 100}$$

$$= 10.0 \text{ KWH/ton cane}$$

(6) Comparison of basic unit of power and steam in production and green bagasse production

A comparison of basic unit of power and steam in the production of one ton of crude sugar obtained in the previous paragraphs (1) through (5) and green bagasse production is shown in the table below.

Comparison of Basic Unit in the Production of One Ton of Crude Sugar and Bagasse Production

	Steam Ton/Ton cane	Electric power KWH/Ton cane
(a) Green bagasse production	0.6	10.0
(b) Basic unit in crude sugar production	0.6	8.0
Difference	0.0	2.0

The total basic unit of power and steam in sugar production is equivalent to 99% in terms of the calorific value of bagasse. However, as the excess bagasse production of some sugar mills is 20—25% (Refer to Section 5), this operating condition is considered to be the minimum requirement. For this reason, a study is to be made on the various operating conditions used for calculation of calorific value and the possibility of excess bagasse production is to be pursued through effective utilization of calorific value of bagasse.

2.7 Estimation of Excess Bagasse

As no definite plan has been worked out for the use of excess bagasse for most of the existing sugar mills, the rate of excess bagasse production is generally considered low. However, as there is such an example as the Central Azucarera de Bais, Negros Island, which has a milling capacity of about 5,000 T/D and produces 35 tons of bagasse pulp by using excess bagasse in the sugar mill, there is a possibility that a considerably large amount of excess bagasse may also be produced by other sugar mills. For this reason, an attempt is to be made to reduce the quantity of bagasse used for fuel through improvement of combustion efficiency of boiler, effective utilization of heat in the manufacturing process and reasonable use of motive power while giving due consideration to various factors used for calculation of calorific value of bagasse discussed in Section 6.

2.7.1 Improvement of Combustion Efficiency of Green Bagasse in Boiler

As the green bagasse directly transported to the boiler room has a water content of about 50%, the temporary storage will dry and reduce its water content to about 30%.

This will increase the effective calorific value of bagasse by about 5% and in turn will increase thermal efficiency of boiler by about 4%.

Although the thermal efficiency of boiler was estimated at low 65% previously, improvement of the efficiency to 70% through combustion control is considered possible.

Through the above two improvement measures a reduction of 12% in the quantity of bagasse is possible.

2.7.2 Reduction in the Volume of Steam Through Thermal Control in the Manufacturing Process

As the quantity of steam used in the evaporator and pan in the sugar sap concentration process is expected to vary considerably depending on the type and capacity of the equipment, a reduction of about 10% in the quantity of steam is considered possible through appropriate thermal control.

2.7.3 Rationalization of Steam and Electric Power Consumption

Although the crushing process in most of the existing sugar mills use steam engines for motive power, high efficiency of motive power should be contemplated through the use of efficient turbine or motor as is seen in the new sugar mill. At present the total electric power demand in the sugar mill is met by private electric power plant. If it is possible to purchase power equivalent to 20 to 30% of the total requirement from commercial power company in the future, the use of diesel engines with low thermal efficiency may be discontinued and a great advantage will be brought about in the plant operation.

Judging from even a few improvement measures discussed in the previous sections 7.1 and 7.2, a reduction of 22% in the quantity of bagasse used as fuel is considered possible.

Although these improvement measures may be easily implemented in the new sugar mill by their new and powerful plants, it will be necessary for the existing plants to make a careful plan for the use of bagasse and make a gradual change.

As has been discussed so far, the production of excess bagasse is estimated to be considerably low at present. However, through improvements of process techniques as previously mentioned, production of excess bagasse in the quantity equivalent to 22% of the total bagasse production will be attained without difficulty.

Estimated Production of Excess Bagasse in Each Island
(1969—1970 period is to be used as basis.)

No.	Name of Island		No. of Mills	Bagasse Production 10,000 T/Y (B.D.)	Production of Excess Bagasse 10,000 T/Y (B.D.)
1	Luzon	Total	9	66.9	14.7
		1-1) North of Manila	6	44.9	9.8
		1-2) South of Manila	3	22.3	4.9
2	Negros	Total	15	181.3	39.8
		2-1) Dumaquete	1	17.1	3.7
		2-2) North of Bacolod	10	116.0	25 5
		2-3) South of Bacolod	4	48.0	10.6
3	Panay	Total	6	40.1	8.8
		3-1) Upperstream of the Jalaur River	4	26.2	5.7
		3-2) Upperstream of the Panay River	3	13.9	3.1
4	Cebu, Leyte	Total for 2 islands	2	17.5	3.9
5	Total	Total for 5 islands	32	305.8	67 2

(1) All mills are assumed to be crude sugar mills by using data from Fig. 3, 4 and 5.

(2) Bagasse production for the CAREBI and the New Frontier Sugar Mills was estimated from their installed capacity (210 d/y).

The production of excess bagasse (22%) in all the islands in 1969 is estimated at 670,000 tons (Bone dry). As for the future growth, an annual growth of 8% (Refer to 4.1) is expected.

CHAPTER 3. PULP AND PAPER PLANTS

SECTION 3. PULP AND PAPER PLANT

3.1 General Description of Manufacturing of Pulp and Paper in the Philippines

There are 20 pulp and paper mills in the Philippines, and almost all mills operate in the vicinity of Manila. They are almost small in scale but producing various papers. The scale of 10 mills is less than 9,000 tons per year, and 8 of them are pulp and paper integrated mill. The only unintegrated mill is now under construction. One mill is in Negros Bais and two are in Mindanao Island. One of them is under construction. 17 mills are in near Manila. Typical mills are as follows, Central Azucarera de Bais in Negros, Bataan Pulp and Paper Mill in Luzon, Rustan Pulp and Paper Mills Inc. and PICOP in Mindanao.

There are many pulp materials used in the Philippines. Details are as follows:

Bagasse:	Bais, Asiatic Steel Division, Aclan etc.
Abaca:	Canlubang, Aclan, Rustan
Bamboo:	Bataan
Lauan:	Rustan, PICOP

Especially, Philippine Pulp Industry makes use of lauan, bagasse and abaca. The quality and quantity of these three materials will compete each other and will contribute pulp industry in the Philippines. According to 1968 statistics, imported amount of waste paper and pulp is 48,700 short ton. This is considerably big amount and far from sell-supplying situation. Therefore pulp industry has a developing market in the future.

3.2 Bagasse As Raw Materials

3.2.1 Bagasse Heat Value

The comparison of heat value between Bunker C oil and fuel bagasse used in sugar mill is as follows:

Bone dry bagasse heat value:	4,600 Kcal/kg
Bunker C oil heat value (sp 0.98):	10,000 Kcal/kg
Bagasse boiler efficiency (abroad):	60%
Oil boiler efficiency:	88%

1) Effective energy from 1 kg bone dry bagasse
   4,600 Kcal/bone dry kg x 60% = 2,760,000 Kcal/bone dry MT

2) Effective energy from 2 barrel oil
   2 barrel = 2 barrel x 159ℓ/barrel x 0.98 kg/ℓ = 312 kg
   312 kg oil x 10,000 Kcal/kg x 88% = 2,750,000 Kcal

3) 1) is equal to 2).
   As to available energy, a bone dry metric ton bagasse is equivalent to 2 barrel Bunker C oil.

3.2.2 Purchased Bagasse Fiber Price (Bone dry basis)

If bagasse becomes more useful than fuel, the planter may tend to want more money than the mere fuel price. If this higher price is incurred, bagasse pulp mill will not be profitable. Therefore, we presume adequate

bagasse price according to maximum price in all over the world, and try to find out basis of cost calculation. This price is maximum, and can be of course reduced by negotiation. However to know the profitability, we presume as follows: Pith is left as its own fuel in sugar mill and pulp mill will not buy it. Namely, following "bagasse" means depithed bagasse.

1) Bonus charge
   1 US$/bone dry bagasse MT = 6.4 Peso/bone dry bagasse MT

2) Energy charge
   Present Bunker C oil price 15 ¢/liter at Ma-ao
   13 ¢/liter at Binalbagan

   After 5 years, (in 1975)
   we presume 20 ¢/liter.

   20 ¢/liter x 159 liter/barrel x 2 barrel/MT bagasse

   = 63.6 Peso/bone dry bagasse MT

3) Total 1) plus 2) = 70 Peso/bone dry bagasse MT

3.2.3. Bagasse Transportation Cost

As green bagasse is bulky and holding 50% moisture, its transportation cost shown at item 3) below, is the same to or more than the price of bagasse itself. Therefore, it is desirable to construct pulp mill at the nearest site of sugar mill.

1) Baling cost based on BAIS Data in Negros Island

   Bale size 1' x 1' x 2' = 0.054 M^3
   35 kg/bale: Green bagasse with 50% moisture
   Density: 35 kg/0.054 m^3 = 0.65 MT/M^3
   Bone dry bagasse 1 MT = $\frac{1,000 \text{ kg}}{35 \text{ kg/bale x } 50\%}$ = 57 bale
   Baling cost: 30¢/bale
   30¢/bale x 57 bale/MT = 17.1 Peso/MT

2) Bagasse density

   Baled bagasse 35 kg/0.054 m^3 = 0.65 MT/M^3
   Bulky bagasse on lorry at 2M high loading = 0.20 MT/M^3

3) Transportation cost per bone dry MT bagasse
   Based on hearing data: It takes about 32 km from Santos Lopez Sugar Central to Iloilo Pier.

	Sugar		Baled Bagasse		Bulky Bagasse	
	Hearing Data	Calculation per MT		Peso per MT		Peso per MT
Baling			From 1) BAIS Data	17.1		
Loading	10¢/Picl	1.58 Peso	Moisture 50% therefore x2	3.16	Moisture 50% therefore x2	3.16
Trans-portation	in 1971 oil: 16¢/liter 54¢/Picl	in 1975 oil: 20¢/liter 10.7 Peso/MT	density ratio: $\frac{1.1}{0.65}$ x1.6 Moisture 50% therefore x2	x1.6x2 =x3.2 34.2	density ratio: $\frac{1.1}{0.2}$ x5.5 Moisture 50% therefore x2	x5.5x2 =x11 117.7
Unloading	10¢/Picl	1.58 Peso	Moisture 50% therefore x2	3.16	Moisture 50% therefore x2	3.16
Bale Breaker			Baling cost x 40% in South America	6.84		
Total	74¢/Picl	13.86 Peso/MT		64.46 Peso/MT		124.0 Peso/MT

Note: Compare with bagasse cost 70 Peso/bone dry bagasse MT:
Sugar particle density: 1.588 MT/M^3
Sugar density in bag: 1.588 x 0.65 = 1.1 MT/M^3
Baled bagasse density: 0.65 MT/M^3

Source: Item 3) of 3.2.2, BAIS Data

3.3 Process of Bagasse Pulp Making

3.3.1 Fiber Dimension

Fiber length of soft wood is about 3 mm and its width is about 1/70 in length. On the contrary, fiber length of hard wood is about 1 mm and its width is about 1/30.

The fiber length of bagasse is about 1.5 mm, and its width is about 1.70. This fact is very important. In so far as bagasse is being depithed just enough, bagasse pulp is essentially competitive with hard wood pulp in the pulp strength.

3.3.2 Necessity of Depithing

There scatters cambium on cross section of sugar cane. Duct grows around it, and we call it PITH. Bagasse fiber adds mechnical strength to cambium and pith in sugar cane. As the depithing process makes bagasse pulp strong, this is necessary for pulp plant.

3.3.3 2-stage Depithing

Although there is "Dry-depithing Process" which is to hammer bagasse in 10% moisture, this processing is not recommendable. Because many bagasse

fibers are subject to be damaged and the pith are not fully separated from fiber. On the other hand, we call Moist-depithing Process which is to hammer bagasse in 50% moisture right after being extruded from sugar mill. This processing prevails all over the world now. Moreover, this moist depithed bagasse is again hammered at 88 - 90% moisture by wet depither. This is what we call "wet depithing process". These two processes are combined, and then depithed bagasse yield reaches to 60%. Thus we can obtain depithed bagasse material for making bright bleached bagasse pulp.

Therefore, we will proceed our discussion according to these 2-stage depithing process.

3.3.4 Cooking Process

There are two classic processes which are "Acid Sulphite process" and "Neutral Sulphite process". But we would not recommend those processes, because these pulp have bad quality and these processes cannot recover chemicals contained in waste liquor. While, "Kraft (Sulfate) Process" and "Soda Process" are the better processes. The reason why we recommend these is such, that the cooking yield and pulp strength are excellent, and chemical recovery system is complete. There is no difference between Kraft and Soda processes from the above view point. However, as to the air pollution, Soda process is superior to Kraft process, and therefore recommendable cooking chemical is "Caustic Soda".

3.3.5 Bleaching Process

For the purpose of producing high brightness GE 86-88° pulp, $C\ell_2$-NaOH-Na Hypo-$C\ell O_2$ which we call "4-Stage Bleaching" is advisable.

3-4 Chemicals for Pulp Plant

Chlorine gas is so poisonous that it often causes many troubles, when chlorine vessels are stevedoring. Therefore, we produce it from salt by electrolysis. When chlorine gas is produced incidentally caustic soda of 1.12 times of the chlorine is produced as cooking and bleaching chemicals. Caustic soda which is short of requirement inquantity can be purchased. What we call required chlorine includes not only $C\ell_2$ bleaching stage but also Hypo and Chlorine dioxide stage. Sodium hypo and chlorine dioxide are made from chlorine gas in pulp plant. There are 2 methods of salt electrolysis, one is "Mercury Method" and the other is "Diaphragm Method". From the stand point of water pollution, we would not recommend "Mercury Method". "Diaphragm Method" is better. By Kesting electrolysis method, sodium chlorate is made from hydrogen chloride, and produces clorine dioxide.

CHAPTER 4. MARKET STUDY OF PULP AND PAPER

SECTION 4. MARKET STUDY OF PULP AND PAPER

4.1 General Trend of Pulp and Paper Industry

4.1.1 Characteristics of Pulp and Paper Industry

The characteristics of pulp and paper industry may be pointed out as follows:

(1) While it requires a vast capital investment, its added value is comparatively low with little profit.

(2) There is a world-wide tendency that the pulp and paper industry is moving toward mass production except for special paper products to cope with the increase in the cost of raw materials. This inevitably brings about over-production and the rate of profit in this industry is far below that in other manufacturing industries in every country.

4.1.2 Present State of Pulp and Paper Industry in the World

Reflecting the sluggish economy in the United State, the pulp and paper industry is stagnant over the world at present time. The market condition for pulp and paper in all lines of products was so bad in the past that production had to be slowed down in every country. Not only the price of paper but also the price of pulp which had been stable until the first half of last year are approaching a turning point.

Turning to high-grade papers which are closely related with bagasse pulp, expansion of production by more than 1,500,000 tons is being planned by European countries (Sweden, Finland, Norway, West Germany) and the East European block (Czechoslovakia, Yugoslavia, Rumania, Bulgaria) by 1974 to worsen the world-wide depression. It is feared that such an expansion in the production will press hard upon the price structure of pulp and paper industry.

On the part of producers, they are strongly inclined to raise the prices of their products to cope with an increase in labor cost and rise of freight charges, overhead and price of raw timber. Additionally, the increase in capital investment for the equipment to cope with pollution problems accelerates this tendency. The intention of manufacturers to raise the prices, however, has not yet been materialized by various reasons.

4.1.3 Trade of Papers in the World

The major paper export countries of the world are the north European countries (Sweden, Finland, Norway, West Germany), the East European block countries (Czechoslovakia, Yugoslavia, Rumania, Bulgaria), the United States, India and Mainland China.

As far as high-grade papers are concerned, Japan is also one of the major export countries and exports its products to 60 to 70 countries.

(1) Present state of import countries in Southeast Asia (For high-grade papers)

1) Hongkong

It is needless to say that this country does not produce papers.

Being a free port, this country imports a very small quantity of European products (high-grade products) and the majority of its demand for papers is met by Japanese high-grade papers. Low priced products are imported from mainland China and India. Those low-grade products are marketed at prices 10~15% less than those of the Japanese products.

2) Singapore and Malaysia

There had been a paper mill in Singapore which became bankrupt last year because of the poor business results. Being a free port like Hongkong, it imports papers in considerably large quantity for re-export purpose.

Although Malaysia imports papers via Singapore, the volume of import is not large. While an additional paper mill is being planned, demand for paper is not so great.

3) Thailand

Pulp and paper industry in this country has made a considerable progress and most of papers except tissue paper and part of special papers are produced domestically. News prints are imported in its total requirement. The quality of domestic news prints is not satisfactory and for this reason, Japanese news prints are being imported at a high tariff for use as high class newspapers.

The business of local paper mills is not on the paying basis and the government is taking a quite strong protective policy for the industry. Furthermore, the government is imposing high tariff on the import of paper and even prohibits the import of some of the products.

4) Indonesia

Like the Philippines, this country has some paper mills (6 to 8 mills). However, due to the lag of social overhead capital, small operating scale and lack of experience (substandard technology), productivity of the paper mills is low and the quality of products is extremely unsatisfactory. Recently considerably high protective tariff rates have been put into effect but imports from Japan still account for a large per cent. Besides, products of mainland China, Taiwan and India are being marketed in small quantity. No products are being imported from European countries because of high freight.

5) Philippines

This country imports 6,000 tons of papers from Japan annually and is also presumed to import a considerable amount of papers from the United States because of its special relations with that country.

It is said that the United States has been dumping its products in this country recently, but details are unknown because of lack of information.

The import duty in the case of book paper is 30%, which is considered to be normal rate for a developing country.

6) Iran

Though not being a Southeast Asia country, this country had been one of the major paper import countries until August of last year when a 3,000 T/month paper mill began operation.

However, because of the poor business results of this mill, the government made changes to the regulation and put forward a protective policy. The government further strengthened its protective policy in last April in an attempt to encourage consumption of domestic papers.

As has been discussed so far, the pulp and paper industries in developing countries are being protected by strong measures of the governments because of poor business results. However, because of poor quality of domestic products, demands for high-class papers are met by imports.

4.1.4 Present State of Bagasse Pulp Production

It is generally said that 80 to 90 per cent of the raw material for the production of paper and board in the world are accounted for to be wood fibers. For this reason, pulp and paper industry has been developing only in the region with rich forest resources until recently. There is a strong world-wide tendency, however, that even developing countries plan the expanded pulp and paper production with their own resources.

Nevertheless, the production of bagasse pulp is limited to the countries where the source of raw material has to be sought in non-wood materials because of limited forest resources such as Taiwan, India, Cuba, Peru, Puerto Rico, Colombia, Argentina, and Brazil.

With the growth of demands for raw timber, extinction of forest resources and the rise of timber prices in the future, the importance of bagasse pulp will increase gradually along with the technological renovation.

4.1.5 Bagasse Pulp in The Philippines

On the use of bagasse pulp, such industrial papers as colugate medium, liner board and back paper are produced from unbleached pulp and high-grade paper and tissue paper are made from bleached pulp.

For industrialization of bagasse pulp in the Philippines, the team recommends pulp breaching equipment and high-grade paper manufacturing facilities. The reason for this recommendation is that such products have a high added value and will reduce the ratio of freight in the production cost for the mill which is located far from the consuming district.

4.1.6 Marketability

(1) Pulp

After shifting from the present imported pulp to bagasse pulp for paper production, export to Southeast Asian countries and Japan is possible when there is an extra capacity.

(2) Paper

After shifting from the present imported paper, export to Southeast Asian countries is possible when there is an extra capacity. For the export of paper, however, reasonable prices and internationally competitive quality are the most important factors.

4.1.7 International Situation Surrounding Pulp and Paper Industry

(1) Supply of pulp in the international market

Supply of pulp in the international market will be discussed at a later stage.

(2) High-grade paper in Southeast Asia

In Southeast Asia, all countries except Hongkong are making frantic efforts for domestic production of high-grade papers. In spite of their efforts, the quality of papers manufactured in these countries is not acceptable as international standard. For this reason, these countries import a considerably large quantity of high-grade papers from Japan for special purposes. Particularly, Hongkong, Singapore and Malaysia import high-grade paper mainly from Japan and partly from North European countries for making export goods. For domestic use, these countries import low-grade papers from Mainland China, India and Taiwan.

As the Philippines also imports Japanese high-grade paper in considerably large quantity and the import is expected to increase in the future with the growth of demand, domestic production of good quality papers will enable the country to discontinue its imports and make it possible for the country to export its products to Southeast Asia market.

However, it is a very difficult question whether an internationally competitive pulp and paper mill can be maintained in the Philippines.

As it is evident that the existing pulp and paper mills cannot survive international competition with the present low rate of operation, how the operating rate may be improved and whether the internationally competitive products may be produced will be the keypoint of the future of pulp and paper industry in the Philippines. As pulp and paper industry is a process industry, it receives a greater effect of ups and downs of general economy. For this reason, the market conditions of pulp and paper are of very fluidity.

Although the prices of products are in the rising trend because of an increase in the price of raw timber, personnel expenses, expansion of anti-pollution facilities and also an increase in the overhead, a large capital investment will have to be made to cope with the increase in various costs and for this reason, the market conditions are in constant fluidity.

It is important, therefore, to make a careful study at the stage of planning of pulp and paper industrialization.

4.2 Pulp and Paper Industry in the Philippines

4.2.1 Pulp and Paper Industry in the Philippines

Most of pulp and paper industry in the Philippines concentrate around

the great consuming city of Manila and there are a total of 20 mills. These mills are generally small in scale and very few are integrated pulp and paper mills. Raw materials of pulp in the Philippines are diversified and the materials now in use are bagasse, abaca fiber and lauan wood.

The existing mills, those under construction and those in planning stage are as follows:

Installed Annual Capacity (ST)

	Pulp	Paper	Paper board
Existing mills	84,700	174,200	46,200
Under construction	140,000	150,500	-
In planning stage	285,000	145,300	
Total	509,700	470,000	46,200

Source: Pulp and Paper Manufacturers' Association (Sept. 3, 1970)

4.2.2 Existing mills

At present the following 18 mills are in operation;

8 integrated mills
9 paper board mills
1 pulp mill

Source: Pulp and Paper,Manufacturers' Association (Sept. 3, 1970)

The pulp mill is very small in scale with an annual capacity ranging from 2,000 to 18,000 ST. Of the paper mills, the Manila Paper Mills Inc. is the largest in scale with an annual capacity of 48,000 ST, followed by the Rustan Pulp & Paper Mills Inc., with an annual capacity of 32,000 ST. The rest are all small in scale as in the case of pulp mill and the annual capacity of each of them ranges from 1,200 ST to 18,000 ST.

4.2.3 Mill Under Construction

The mill under construction is that owned by the Paper Industries Corp of Philippines, which is scheduled to be completed in June, 1971. Whether it will be completed on schedule has not been confirmed.

The line of product includes pulp, news prints, liner board, kraft paper.

GP - 50,000 ST, Kp - 90,000 ST

4.2.4 Mills in the Planning Stage

At present 7 new paper mills are being planned. Except the special paper mill, all of them are large scale mills, each having an annual capacity of more than 30,000 tons.

Though it is still to be seen how many of them will be actually put into operation, completion of all of them, if realized, will increase the pulp production capacity by sixfold and the paper production to about 2.7 times.

4.2.5 Production Capacity and Achievements of Pulp and Paper Industry As of 1968 (ST)

	Paper	Pulp (Data for 1968 is most recent data available)
Annual installation capacity	157,200	52,800
Production	126,900	20,600
Rate of operation	80.7%	39%

Source: a) The Forest Products Research and Industries Development Commission

b) Industrial Programs Office

As is evident from the above table, the rate of operation for the paper mills was 80.7% and that for the pulp mills was 39%. It should be noted that the rate of operation for the pulp mills is extremely low. The low rate of operation for the pulp may be attributed to the slow progress of related industries, unavailability of raw materials, substandard technology and lack of definite information on the production due to tariff problems in the Philippines. Therefore, the actual production is considered to be slightly higher than this.

In any event, the pulp and paper industry, as a process industry, cannot survive with such a low rate operation. It is essential, therefore, to give due consideration to this point in planning industrialization of pulp and paper in this country.

Production of Pulp and Paper in 1960~1966 Period

Year	Pulp			Paper		
	Capacity	Production	Rate of Operation	Capacity	Production	Rate of Operation
1960	15,000ST	9,800ST	65 %	86,200ST	53,700ST	62 %
1961	15,000	14,100	94	99,800	67,700	68
1962	43,600	15,850	36	136,400	70,600	52
1963	49,500	28,900	58	145,000	90,700	63
1964	54,800	22,900	42	145,500	88,800	61
1965	54,800	18,000	33	145,500	89,500	57
1966	54,800	22,500	41	151,000	113,250	75

Note: No data is available for 1967.

As shown in the above table, the rate of operation for pulp is extremely low ranging from 33% to 65% except in 1961 when the rate was 94%.

The rate of operation for paper is also very low ranging from 52% to 68% except in 1966 when the rate was 75%, showing the peculiarity of this country. (low utilization of rated capacity)

4.2.6 Paper Supply and Demand

Source: RP's Pulp and Paper Industry by Francisco P. Monge

Pulp and Paper ---------- The Board of Investments

As no systematic data was available and statistical data available carry conflicting figures, data on consumption and imports used was that provided by the Pulp and Paper Industry and the supply and demand forecast for the 1970—1974 period was based on BOI data.

(Unit: MT-approximate)

Year	Consumption			(A)	(B)	(A)-(B)	
	Industrial papers	Printing & writing papers	Others	Total	Import		Production (about)
1963	46,000	46,500	48,500	141,000	123,000	45,000	(80,000)
1964	61,000	47,000	60,000	168,000	115,000	55,000	(80,000)
1965	64,000	41,000	65,000	170,000	128,000	49,500	(102,000)
1966	56,500	54,000	67,000	177,500	148,000	50,800	-
1967	67,800	43,000	88,000	198,800	154,000	63,500	(126,900)
1968	86,500	50,000	81,000	217,500			

(Note) : Figures for production represent the achievements mentioned in the previous paragraph in terms of MT.

Properly speaking, the figure obtained by the subtraction of import (B) from the total of consumption (A) in the table above should match the figure for domestic production mentioned in the previous paragraph, but in actuality, figures fluctuate greatly each year. This is due to a lack of systematic data and therefore only the growth rate of consumption will have to be discussed here.

The average annual growth rate of the consumption of all papers in the 1963—1968 period was 9% and the rate of industrial paper was such high as being 17.6%.

The extremely low average annual growth rate in the consumption of printing and writing paper, which is being 15%, is attributable to the unbalance in supply and demand as the consumption is low compared with imports and domestic production.

Forecast of Domestic Paper Supply and Demand for the 1970~1974 Period

Year	Demand	Domestic Production	Shortage
1970	276,000	105,630	170,370
1971	296,000	200,000	96,000
1972	320,000	233,000	87,000
1973	345,000	282,000	63,000
1974	373,000	284,000	89,000

Source: Pulp and Paper (BOI)

(1) No supply and demand forecast by product type is available. The above table was the only supply and demand forecast obtained by the team.

(2) The production forecast for 1970 given as 105,630 MT in the above table indicates the difference of the figure of the base year since other source gives the achievement of 114,200 MT in 1968.

(3) According to the calculation (estimation) by BOI, the annual growth rate of 8% with 1968 as base year will increase demand in 1970 to 276,000 MT and with the same growth rate the demand in 1974 will increase to 373,000 MT.

(4) When all the mills now under construction and in the planning stage mentioned in the previous paragraph are completed the annual capacity should reach 465,000 MT. According to BOI data, however, the production forecast for 1974 is only 284,000 MT, which means that the facilities for 200,000 MT out of the planned production will be completed after 1975.

(5) Regardless of the conflicting data or ambiguitity in the information, it may be appropriate to consider that the supply shortage will continue until 1974.

4.2.7 Feasibility of Integrated Bagasse Pulp and Paper Mills in the Philippines

(1) Probability of exporting papers

As mentioned previously, all Southeast Asian countries except Hongkong are making strenuous efforts to materialize domestic production of papers of all types. Despite their attempts, however, the quality of papers manufactured in these countries is not satisfactory, and the chief reasons are that their paper and pulp manufacturing techniques have not yet attained the standard level and that they have to rely on import for the supply of needle leef wood pulp (long fiber) but have to restrain the import of pulp for blending in order to save foreign currency or prevent the rise of cost.

Consequently, they will have to choose higher class than their own for special purposes. If their products are equipped with quality equivalent

to at least that of Japan, they will be competitive in the international market and will have potentialities for export.

Although Japan's dependance on import for the supply of raw wood and pulp chips is increasing annually, it is one of the major paper exporting countries. Though the ratio of paper in the total export is relatively low, it is considered difficult to attain the level of 200 million dollars (Estimation for 1970) in the export of papers including some paper products. As for the import of papers, Japan imports only special high-grade papers in small quantity and some mechanical printing paper, a mass produced paper manufactured mainly from conifer pulp.

Therefore, until the Philippines is able to manufacture papers of internationally competitive quality, export of papers to Japan from this country is not conceivable.

The paper industry in the Philippines, therefore, should aim mainly at the production of high-grade papers which are in great demand in the country and supply of which is dependent on import.

(2) International pulp market

The major pulp exporting countries of the world such as Canada, Finaland, Norway, Sweden, U.S., and also Japan have been expanding the their pulp production facilities in the period from the latter half of last year to the middle of this year and pulp industry in Japan shows enthusiasm for export of only L-BKP as a temporary measure. Paper demand in the world over is stagnant under the influence of world-wide business depression and as a result, there is surplus supply of pulp. When the economy get rid of this business slump depends entirely on the recovery of American economy. This weak tone of economy, however, may be regarded as a temporary phenomenon. Import of pulp by countries in Southeast Asia (including Japan) and European countries except the three North European countries amounts to a considerable quantity. Japan and other Southeast Asia countries import mainly N-BKP from Canada and the United States. As it is not clear whether the pulp importing countries other than Japan need bagasse pulp or not, only the situation in Japan will be discussed.

The type of pulp is diversified and includes the followings.

N-BKP, NYKP, N-UKP, L-BKP, L-UKP, L-YKP, N-BSP, N-USP, I-BSP, SCP, CGP, SCP, R-GP, GP

Notes:	N-BKP	Soft wood pulp
	U	Unbleached
	B	Bleached
	L	(Broad Leaf Wood)
	N	(Needle Leaf Wood)

It is the characteristic of the Japanese pulp industry that L-BKP is produced by large integrated pulp and paper manufacturers and only part of it is placed on market for sale to medium and small scale paper manufacturers. This means that selling expenses can be saved in each process. The imported N-BKP is used by medium and small scale manufacturers who do not have their own pulp mills or by the manufacturers who have special

requirements for needle leaf wood pulp. Although the supply of L-BKP has a surplus and has room for export, this phenomenon is only temporary. As there is no doubt that the supply of this pulp will become short in the future, Japan will be a big market for bagasse pulp.

As the chief competitor of bagasse pulp will be L-BKP, it will be necessary for the bagasse pulp to be available at low prices to compete not only with Japan's commercial pulp but also with the integrated pulp manufacturers in Japan. For this reason, it may be said that the marketing of bagasse pulp in Japan will be meaningless from a commercial point of view unless it is sold at attractive prices.

As far as L-BKP is concerned, Japan almost monopolizes production of this type of pulp or it may be said that Japan is the only country in the world to manufacture L-BKP at present. Quality of the pulp is considered to be of the international standard. Therefore, the bagasse pulp, if used for this classification, must have good quality.

4.2.8 Prospects of Pulp Supply

At present Canada ranks first in the world pulp export. In Canada pulp and lumber industries are the mainstay of her economy. The Canadian manufacturers opine that their business is not commercially payable with the present price structure (C&F$180/ST in Japan). They say that they cannot make positive investment unless the price is raised to C&F$200/ST. Therefore, it is certain that the price will reach the $200/ST level in the future although there may be a temporary downward trend at time.

When the rise of wage and freight, increase in the cost of raw wood and other expenses and requirement for capital investment in antipollution facilities in the future are taken into consideration, the price increase exceeding even the $200/ST level is conceivable. The size of the mill will become larger and larger in the future to catch up with the increase of the production cost.

In Japan the problem of environment pollution has become a big issue and a shortage of wood resources presents a serious problem. For this reason, it is not clear how long the present expansion of pulp manufacturing facilities will be allowed. It is anticipated that in the future expansion of large pulp manufacturing facilities will have to be suspended or restricted in the number. At that time the use of bagasse pulp as a substitute of L-BKP will be taken up positively.

In Japan the price of L-BKP delivery on arrival is $138 — 140/MT. As L-BKP is scarecely produced in the United States and is used only for special pulp, there is no difference between L and N as in the case of Japan.

Imports of Paper and Paper Board (1969)
in the Philippines

Description	Quantity (MT)
News prints	71,376
Coated paper	1,194
Book paper	6,637
Other high-grade paper	1,407
Tissue paper	1,843
Kraft paper	13,126
Wrapping paper	1,480
Jute liner	1,110
Board of various types	58,026
Others	12,065
Total of paper & board	168,269
Paper products	5,485
Grand total	173,754

Source: Central Bank of the Philippines

Imports of Pulp and Waste Paper (ST)
in the Philippines

Year	Pulp	Waste Paper	Total
1964	30,700	4,700	35,400
1965	19,800	10,800	30,600
1966	26,500	21,000	47,500
1967	36,400	10,500	46,900
1968	44,000	4,700	48,700

In 1969 (January~November) 3,825 MT of bagasse pulp was imported from Taiwan.

Taiwan Pulp and Paper Corp.

Kimberly Clark
Scott Paper
KENG HUA

Tariff Rates at Present

Type of Paper:	Ad valorem
News prints	25 %
Book paper	30
Mimeograph paper	40
Bond paper and Onionskin paper	60
Cigarette paper exceeding 15 cm in width	10
Kraft paper	80
Cleansing and toilet tissue paper	60
Carbonizing tissue paper	15
Stencil tissue paper stock	65
Others	

CHAPTER 5. ECONOMIC ANALYSIS OF PULP AND PAPER PLANT

SECTION 5. ECONOMIC ANALYSIS OF PULP AND PAPER PLANT

5.1 Species of Pulp and Paper

According to the market research discussed in Section 4, when unbalanced bagasse pulp is used for some kind of cement bag paper and corrugating medium, added value of the bagasse pulp is so cheap that it cannot absorb interland ocean freight. More over cement bag paper manufacturing is subject to be influenced by recession of constructors. Actually there is mill under construction in San Ferdinand, and we would like to avoid competition with this. Middle class and low class paper mills have to face with the severe competition in international market. Therefore, book paper and writing paper are recommended as wood free fine paper under these surrounding conditions. Unless tissue paper is made from bagasse pulp near the consuming area, its product is so bulky that transportation cost is expensive. Therefore, we do not take the tissue paper into our consideration in this survey.

5.2 Case Study of the Two Suggested Proposals

5.2.1 Outline

International competitive scale of pulp mill is, even in the case of wood pulp plant, 500-1,000 Metric ton/day plant. But with the limit of bagasse collection and water source in this island, bagasse pulp plant capacity is more or less 200 MT per day. But if 200 MT/D paper is produced 330 days per year, about 70 thousand metric tons fine paper causes some trouble in the Philippines paper market as is shown in Section 4. Therefore, fine paper should be made from only 100 MT bagasse pulp out of 200 MT pulp produced every day, and the remainder of produced pulp will be sold to tissue or other paper mill in grater Manila. On these assumptions the Case-2 is discussed. In future, water pollution and air pollution in Manila will cause problems and therefore pulp production will be very difficult in Manila area.

However, from the view point of difficulty of getting the construction cost or capital, the mill scale is assumed to be a half of the above, and the fine paper is made from all produced pulp. We call this Case - 1. Case 2 has much more scale merit than Case 1, and production cost of Case 2 is cheaper but its initial investment larger.

In both cases, pulp mill is assumed to operate during 11 months a year, sugar mill operates for 8 months. And during 3 months between above 11 and 8 months, pulp mill uses stored moist depithed bagasse. In the case of Victorias Sugar Mill in Negros, the mill operates during 11 months, so it is beneficial not only in terms of cost but also of better pulp quality which is homogeneous in all season.

5.2.2 Construction Cost

The local cost in the Philippines is presumed as same as in Japan. The reason why we presume same is that the labour cost is very cheap whereas submaterial is expensive. It is necessary to make a detailed survey at the occasion of next feasible study.

	Rate %	Case 1 (M$)	Case 2 (M$)	Remarks
Ocean Freight	3.3	0.6	0.9	
Instrument	55.3	10.0	15.32	
Erection	11.6	2.0	3.2	As same as in Japan
Construction	14.9	2.7	4.12	"
Consulting Engineering	14.9	2.7	4.12	
Total	100.00	18 Million Dollars	27.66 Million Dollars	

Note: 1. Calculating base -- 1973 Ordering
1975 Finishing

2. "Interest" under construction is not included.

3. "Operation Capital and Site Purchasing Fund" is not included.
If included,
Case 1: 2 Million $, 4 hectare = 200 M x 200 M
Case 2: 3 Million $, 6 hectare = 200 M x 300 M

5.2.3 Cost Evaluation (Profit after the amortization is not included.)

Basis of Caluculation

1) Interest

Foreign Loan (75%)		10%/year
Local Fund	(25%)	14%/year
Average		11%/year

2) Depreciation Durable years: 12.5 years
8%/year Straight line method

3) Maintenance Fee Minimum 1.5% or more of total investment but we assume 1.5%. This rate will be finalized after making a detailed survey of local maintenance conditions.

4) Unit Price

Bunker C-oil in 1975	Peso 0.20/liter
Bagasse	Peso 0.07/bone dry kg
Salt	US$ 30/MT
Caustic Soda (Flake)	US$250/MT
Electric Power	US$ 0.0055/KWH
Steam	US$ 1.67/MT

These data are based on following assumption:

1 kilo liter oil generates both 15 MT steam and 1,500 KWH power.

5) Operation 330 days/year

6) Salary and Wages

Peso 25/8 hours including fringe benefits in 1975

Case - 1

Pulp Plant	250 persons	(including head office and maintenance shop)
Paper Plant	150 persons	
Total	400 persons	

Case - 2

o	Slush pulp plant for paper (half share)	150 persons (including head office and maintenance shop)
	Paper plant	150 persons
	Sub Total	300 persons
o	Slush pulp plant for sale (half share)	150 persons
	Pulp machine	50 persons
	Sub Total	200 persons
	Grand Total:	500 persons

7) Paper machine yielding 89%

100 MT bagasse pulp plus 12 MT NBKP plus 12 MT clay is equal to 124 MT. This produces 110 MT fine paper, therefore $\frac{110}{124} = 89\%$.

8) Bagasse Consumption

Bone dry depithed bagasse consumption for airdry pulp 100 MT is 182 MT of bleached bagasse. The amount of green bagasse required before 2-stage depithing for 60% yield is 608 MT (including 50% moisture), or 304 MT in bone dry basis.

According to the average value of our survey which is shown in Section 3, there is 13.2 MT bone dry bagasse per 100 MT sugar cane. Therefore 2,300 MT sugar cane is needed to produce 100 MT bleached bagasse pulp. If it operates annually 330 days, it needs 760,000 MT sugar cane or 200,000 MT green bagasse of 50% moisture or 100,000 MT bone dry bagasse.

Therefore, sugar mill which annually exhausts 100,000 MT bone dry bagasse is able to have a 100 MT/D bleached bagasse pulp plant.

9) Moisture content of pulp and paper

Our calculation is made with 10% moisture content, which is currently adopted all over the world.

Case-1 100 MT/Day Bagasse Pulp Plant Capacity: Slush Pulp Cost

Capital Cost Share of Case 1: 63.4%

	Unit Price	Consumption MT per 100 MT pulp	Cost (thousand Yen)	Remarks
Depithed bagasse	4,200 ¥/MT	182	765	
Salt NaCl	10,800 ¥/MT	10	108	
Caustic Soad NaOH	90,000 ¥/MT	3	270	
Electric Power	2 ¥/KWH	100,000 KWH	200	
Steam	600 ¥/KWH	200	120	Total consumption - BLB generation - pulp M/C = 800 - 300 - 200 = 200
Wires and felts for sheet making	-			
Kiln operation	1 ¥/kg		100	Bunker C oil and lime stone
Wrapping material	-			
Maintenance fee	$18,000,000 x 63.4% x $\frac{1.5\%}{1\ year}$ x $\frac{1\ year}{330\ days}$		180	
Salary and wages	1,500 ¥/person 8 hours	250 persons	375	
Capital cost	$18,000,000 x 63.4% x $\frac{(11\%\ plus\ 8\%)}{1\ year}$ x $\frac{1\ year}{330\ days}$		2,340	
Total Mill Cost per 100 MT per kg			4,458 (thousand Yen) 44.58 ¥/kg	

Case-1 110 MT/Day Paper Plant Capacity; Mill Gate Cost of Paper

Capital Cost Share of Case 1: 36.6%

	Unit Price	Consumption MT per 110 MT paper	Cost (thousand Yen)	Remarks	
Bagasse pulp	44,580 ¥/MT	100	4,458		
Clay	25,000 ¥/MT	12	300	In Japan 15,000 ¥/MT	
NBKP	C&F 200$/ST 90,000 ¥/MT	12	1,080		
Electric Power	2 ¥/KWH	66,000 KWH	132		
Steam	600 ¥/MT	550	330		
Wires and felts for sheet making	2 ¥/kg		220		
Auxiliaries kerosene, alum water treatment chemicals	3 ¥/kg		330	Include 100 MT/day bagasse plant use	
Wrapping material	2.5 ¥/kg		275		
Maintenance fee	$18,000,000 x 36.6% x $\frac{1.5\%}{1\ \text{year}}$ x $\frac{1\ \text{year}}{330\ \text{days}}$		108		
Salary and wages	1,500 ¥/person	150 persons	225	Paper plus pulp = 1575 plus 2715 = 4,290,000 ¥	
Capital Cost	$18,000,000 x 36.6% x $\frac{(11\%\ \text{plus}\ 8\%)}{1\ \text{year}}$ x $\frac{1\ \text{year}}{330\ \text{days}}$		1,350	Operation rate if 80% plus 1,070;	if 60% plus 2,850
Total Mill Cost per 110 MT			8,808 (thousand Yen)	9,878 (thousand Yen)	11,658 (thousand Yen)
per kg			80.07 ¥/kg	89.80 ¥/kg	106 ¥/kg
per ST			200 $/ST	224 $/ST	265 $/ST

Case-2 200 MT/Day Bagasse Pulp Plant Capacity, with 100 MT/Day Pulp Sheet Making; Pulp Sheet Mill Gate Cost

Capital Cost Share of Case 2: 42.3%

	Unit Price	Consumption MT per 100 MT pulp	Cost (thousand Yen)	Remarks	
Depithed bagasse	4,200 ¥/MT	182	765		
Salt NaCl	10,800 ¥/MT	10	108		
Caustic Soda NaOH	90,000 ¥/MT	3	270		
Electric Power	2 ¥/KWH	100,000 KWH	200		
Steam	600 ¥/MT	500 *	300	* Total consumption - BLB generate = 800 - 300 = 500 MT	
Wires and felts for sheet making	1 ¥/pulp kg		100		
Kilm operation	1 ¥/pulp kg		100	Bunker C oil and lime stone	
Wrapping material	2 ¥/pulp kg		200		
Maintenance fee	$27,660,000 x 42.3% $\times \frac{1.5\%}{1\ \text{year}} \times \frac{1\ \text{year}}{330\ \text{days}}$		190		
Salary and wages	1,500 ¥/person 8 hours	200 persons	300		
Capital cost	$27,660,000 x 42.3% $\times \frac{(11\%\ \text{plus}\ 8\%)}{1\ \text{year}} \times \frac{1\ \text{year}}{330\ \text{days}}$		2,400	Operation rate if 80% plus 675;	if 60% plus 1,800
Total Mill Cost per 100 MT			4,933 (thousand Yen)	5,608 (thousand Yen)	6,733 (thousand Yen)
per kg			49.33 ¥/kg	56.08 ¥/kg	67.33 ¥/kg
per ST			123 $/ST	140 $/ST	168 $/ST

Case-2 200 MT/Day Bagasse Pulp Plant Capacity;
100 MT/Day Slush Pulp Cost

Capital Cost Share of Case 2: 34%

	Unit Price	Consumption MT per 100 MT pulp	Cost (thousand Yen)	Remarks
Depithed bagasse	4,200 ¥/MT	182	765	
Salt Nacl	10,800 ¥/MT	10	108	
Caustic Soda NaOH	90,000 ¥/MT	3	270	
Electric Power	2 ¥/KWH	100,000 KWH	200	
Steam	600 ¥/MT	200	120	Total consumption - BLB generate - pulp m/c = 800 - 300 - 300 = 200
Wires and felts for sheet making	-			
Kiln operation	1 ¥/pulp kg		100	Bunker C oil and lime stone
Wrapping material	-			
Maintenance fee	$27,660,000 x 34% $\times \frac{1.5\%}{1 \text{ year}} \times \frac{1 \text{ year}}{330 \text{ days}}$		151	
Salary and wages	1,500 ¥/person 8 hours	150 persons	225	
Capital Cost	$27,660,000 x 34% $\times \frac{(11\% \text{ plus } 8\%)}{1 \text{ year}} \times \frac{1 \text{ year}}{330 \text{ days}}$		1,920	
Total Mill Cost per 100 MT			3,859 (thousand Yen)	
per kg			38.59 ¥/kg	

Case-2 200 MT/Day Bagasse Pulp Plant Capacity;
with 110 MT/Day Paper Making;
Mill Gate Cost of Paper

Capacity Cost Share of Case 2: 23.7%

	Unit Price	Consumption MT per 110 MT paper	Cost (thousand Yen)		
Bagasse pulp	38,590 ¥/MT	100	3,859		
Clay	25,000 ¥/MT	12	300	In Japan 15,000 ¥/MT	
NBKP	C&F 200 $/ST 90,000 ¥/MT	12	1,080		
Electric power	2 ¥/KWH	66,000 KWH	132		
Steam	600 ¥/MT	550	330		
Wires and felts for sheet making	2 ¥/kg		220		
Auxiliaries kerosene, alum water treatment chemicals	5 ¥/kg		550	Includes 200 MT/day Bagasse plant use.	
Wrapping material	2.5 ¥/kg		275		
Maintenance fee	$2,766,000 x 23.7% $\times \frac{1.5\%}{1\ \text{year}} \times \frac{1\ \text{year}}{330\ \text{days}}$		108		
Salary and wages	1,500 ¥/person 8 hours	150 persons	225	Paper plus pulp = 1575 plus 2145 = 3,495 (thousand Yen)	
Capital cost	$2,766,000 x 23.7% $\times \frac{(11\%\ \text{plus}\ 8\%)}{1\ \text{year}} \times \frac{1\ \text{year}}{330\ \text{days}}$		1,350	Operation rate if 80% plus 870	if 60% plus 2,320
Total Mill Cost per 110 MT			8,429 (thousand Yen)	9,299 (thousand Yen)	10,749 (thousand Yen)
per kg			76.60 ¥/kg	84.53 ¥/kg	97.72 ¥/kg
per ST			191 $/ST	211 $/ST	244 $/ST

5.2.4 Profitability Study

1) Mill gate cost summary

In the foregoing, we studied cost evaluation of each case, which is shown below. The operation ratio 80% is average operation efficiency.

The low efficiency of operation is due to the bad market situation or untrained operation.

	Operation	100 %	80%	60%
Case-1	Wood free fine paper	200 $/ST	224 $/ST	265 $/ST
Case-2	Wood free fine paper	191 $/ST	211 $/ST	244 $/ST
	Pulp	123 $/ST	140 $/ST	168 $/ST

2) Inland freight (for instance in Negros Island)

According to Section 3, sugar transportation cost for 32 km is 13.86 Peso/MT or 12.5 Peso/ST. Since the weight of sugar and paper is nearly equal, we assume its inland freight 2 US$/ST.

3) Ocean freight (for instance from Negros to Manila)

If we use a chartered ship of 8,000-ton class, the ocean freight is as follows:

Vancouver ⟶ Tokyo 18 $/ST
Hawaii ⟶ Tokyo 15 $/ST

We can not forecast exactly transportation market of 5 years later, but if we transport the cargo by 3,000-ton class chartered ship from Negros to Manila, the ocean freight is supposed to be about 8 $/ST.

It is necessary to conduct a detailed survey for further exactness.

4) Manila C&F cost

From the above 1), 2) and 3), we get the followings:

	Operation	100%	80%	60%
Case-1	Wood free fine paper	210 $/ST	234 $/ST	275 $/ST
Case-2	Wood free fine paper	201 $/ST	221 $/ST	254 $/ST
	Pulp	133 $/ST	150 $/ST	178 $/ST

5) Selling price of Manila C&F

The quality of paper in Manila market is not known to us. However if it is the same as in the South America, for example in Colombia, the

bagasse paper price is the same as paper made from wood pulp. If the paper price is same, it will be calculated as follows.

Book paper

a) CIF Manila 240 $/ST
b) Import duty 30% 72 $/ST
c) Sales tax 7% 27 $/ST
(240 + 72) x 125% = 390 $/ST
(presuming profit of 25%)
390 $/ST x 7% = 27 $/ST
d) Total = a) + b) + c) = 339 $/ST
339 $/ST x 6.5 Peso/$ = 2,203.5 Peso/ST
ST: 2,000 lbs.
therefore 1,102 Peso/lb
This is importer's net cost.
e) The actual market price includes L/C, Usance interest: 1.2 Peso/lbs
f) Competitive domestic book paper price of Manila C&F:
(240 $/ST + 72 $/ST) x (100-4)% = 300 $/ST
minus 4%: commission
after the pioneer discount: 300 $/ST x (100-5)% = 285 $/ST

Bagasse pulp C&F Manila

Actual sitaation
NBKP 200 $/ST ~ 180 $/ST

If any
LBKP 180 $/ST ~ 160 $/ST

Therefore, estimated bleached bagasse pulp price including pioneer discount is:

170 $/ST ~ 150 $/ST
average 160 $/ST

6) Profit after amortization

	Operation	100%	80%	60%	Selling price Manila C & F
Case 1	Wood free fine paper	75 $/ST	51 $/ST	10 $/ST	285 $/ST
Case 2	Wood free fine paper	84 $/ST	64 $/ST	31 $/ST	285 $/ST
	Pulp	27 $/ST	10 $/ST	-18 $/ST	160 $/ST

Of course the profitability of this project depends upon selling price of pulp and paper. But as an example, the presumed annual profitability is as follows.

Fine paper 110 MT/Day x 330 Days/year x 1.10 ST/MT
= 40,000 ST/year

its 80% = 32,000 ST/year
its 60% = 24,000 ST/year

Pulp 100 MT/Day x 330 Days/year x 1.10 ST/MT
= 36,300 ST/year

its 80% = 29,000 ST/year
its 60% = 21,800 ST/year

1,000 $/year	Operation	100%	80%	60%
Case-1	Wood free fine paper	3,000	1,630	240
Case-2	Wood free fine paper	3,360	2,050	740
	Pulp	980	290	-390
	Total	4,340	2,340	350

7) Profitability of capital investment

The selling price of paper $285/ST
The selling price of pulp: $160/ST

	Operation	100%	80%	60%	Investment Million $
Case-1	Wood free fine paper	16.7%	9.1%	1.3%	18.0
Case-2	Wood free fine paper & pulp	15.8%	8.4%	1.3%	27.66

If paper selling price goes down, paper: $270/ST
pulp: $160/ST

Profitability of capital investment is as follows:

	Operation	100%	80%	Investment Million $
Case-1	Wood free fine paper	13.3%	6.4%	18.0
Case-2	Wood free fine pulp	13.5%	6.7%	27.66

Case-2 has the resistivity against the fall down of paper price. When fine paper and bleached bagasse pulp price is adequate, and there are no pioneer discount and no quality discount, the selling price of paper is 300 $/ST and the selling price of pulp is 170 $/ST.

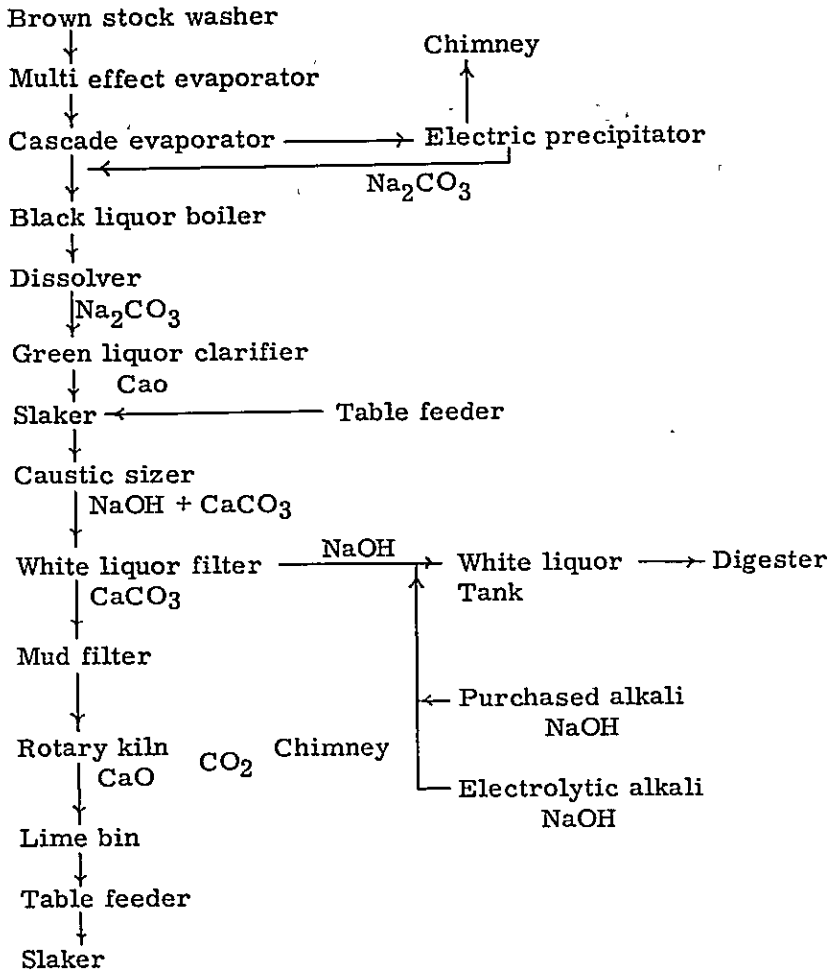
Profitability of capital investment is as follows:

	Operation	100%	80%	60%	Investment Million $
Case-1	Wood free fine paper	20.0%	11.8%	3.3%	18.0
Case-2	Wood free fine paper & pulp	18.5%	11.3%	3.3%	27.66

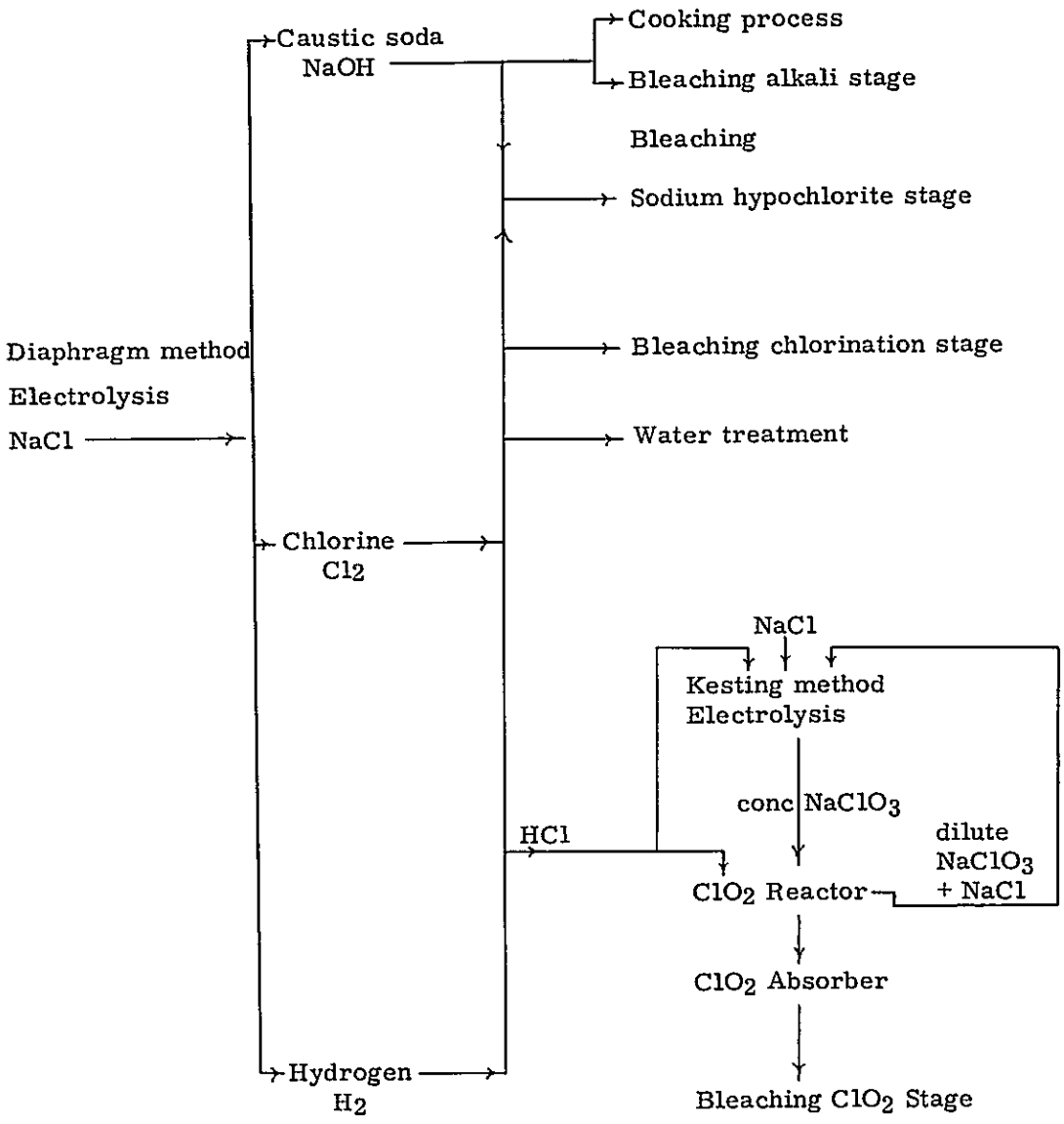
5.2.5 Flow Sheet

1) Pulp plant
↓
Sugar mill
↓
Bagasse conveyor
↓
Moist depither ——Moist pith——→ Pith boiler
↓ ——→ Bagasse storage
Hydra pulper
↓
Drainer conveyor
↓
Wet depither —Wet pith→ Pith press ——→ Pith boiler
(Possession of moist and wet pith belongs to sugar mill)
↓
Digester ——→ White liquor tank
↓
Blow tank
↓
Brown stock washer ——→ Evaporator
↓
Screen
↓
Chlorination tower
↓
Filter
↓
Alkali extraction tower
↓
Filter
↓
Sodium hypochlorite bleaching tower
↓
Filter
↓
Chlorine dioxide bleaching tower
↓
Drum screen
↓
Centrifugal screen
↓
Conditioning
↓
Pulp machine or paper machine

2) Cooking chemical plant



3) Bleaching chemical plant



CHAPTER 6. CHEMICALS FOR THE MANUFACTURING OF PUPL AND PAPER

SECTION 6. CHEMICALS FOR THE MANUFACTURING OF PULP AND PAPER

Various chemicals are required for pulp and paper industry, and differ in the process of manufacturing paper and pulp. Generally speaking, chemicals used for pulp and paper industry are as follows, and most of them, except the main chemicals, are available at local market.

6.1 Sugar Mill

Chemicals to be used in sugar mills are as follows:

(1) Lime stone or Calcium oxide
(2) Ionic exchange resins and phosphate salts for the treatment of water used for boilers
(3) For the extinction of oxygen remaining in the boiler feed water, such as hydrazin.
(4) Caustic soda (97%)
(5) Sulphuric acid (98%)
(6) Aluminum sulphate for purifying river water

6.2 Pulp Plant

(1) Ionic exchange resins for the treatment of water used for boilers
(2) Aluminium sulphate for purifying river water
(3) Lime stone
(4) Supplemental caustic soda (flake)
(5) salt
(6) Caustic soda (made by electrolysis inside the plant)
(7) Chlorine (made by electrolysis inside the plant)
(8) Hydro-chloric acid (made by electrolysis inside the plant)
(9) Sodium chlorate
(10) Chlorine di-oxide

6.3 Paper Plant

(1) Caustic soda (flake)
(2) Sodium silicate (40°Be')
(3) Hydrogen chloride
(4) Aluminium
(5) Kaolin

Chemicals required for the manufacture of pulp and paper are mostly available in the Philippines' market. Caustic soda and chlorine, however, are required in big quantities and are essential raw materials for the paper and pulp industry, and thus it is necessary to ensure the stable resources of them. It is advisable to integrate it with the pulp and paper plant in order to reduce production cost. It is also recommended that salt electrolysis plant is to be installed in the same plant, in which caustic soda, chlorine, hydrochloric acid, and chlorine compounds are produced. It is also recommended that as the salt electrolysis process, kesting process with high efficiency be installed. This process will eliminate various dangers caused by chlorine gas and chlorine-dioxide which are poisonous and flamable. As river pollution problems have arisen in the Philippines, it is suggested to discontinue salt electrolysis process using mercury.

6.4 Basic Chemical Industries Correlated with Paper and Pulp in the Philippines

In the foregoing paragraph chemicals needed in the pulp and paper plant are discussed. In connection with this, the outline of chemical industries in the Philippines is given below. In manufacturing these chemicals such are in question as the capacity of the plants producing these chemicals, the balance between demand and supply, market price, and the condition of acquiring the other chemicals. Although the effect of adapting the floating exchange system are not generally taken into consideration, we can not continue our discussion without referring to this point. This means that the rate of Peso to 1 US$ change from 4.2 to 6.2. The adaption of this floating system has risen the price of chemicals considerably.

Table 1. Rated Capacity, Real Production and Utilization

	1 9 6 7		
	Rated Capacity	Production	Utilization
Sulphuric acid	390,000	136,086	11%
Caustic soda	25,500	24,000	
Chlorine	23,000	-	
Ammonia	136,000	35,389	26%
Ammonium-sulphate	203,400	92,446	45%
Aluminium-sulphate	39,000	4,277	
Salt	210,000	175,420	83%
Vinyl chloride	81,000	60,000 (estimated)	

Source: Office of National Planning, National Economic Council
JCI Report

It is understood from the above table that the production or utilization of rated capacity is low, and these come from such many causes, and can be explained as follows:

1) Difficulties in the techniques of production
2) Import of the tax-exempt goods
3) Unsuitable investment
4) Governmental guidance for the economic development

The whole production of these industries in 1967 are estimated about ₱116 million. The total investment in chemical industries during the same period was ₱360 million, so that ratio of investment to total production was 3:1.

6.4.1 Industry

Caustic soda, chlorine, and chlorates necessary for pulp and paper industry depend on salt as their raw materials. But since the salt in the Philippines,are wholly produced by solar salt production method, the quality is of low grade and the production quantities are limited to small amount. As to

the annual consumption figures, Dr. Curt Schakvoski of United Nations made an estimation of 7 - 8 kg/person. At present, population of the Philippines is estimated to be 34.6 million and from this data salt consumption was estimated at 276,800 tons in 1967, and 359,390 tons in 1975 basing on the assumption of the population as 44.92 million. The salt production was started in 1952 at Negros Occidental, and later Salt Industry of the Philippines Inc. was established at San Jose, Mindro Island using the vacuum evaporation process with the capacity of 300 tons/day in 1959. Then, Pacific Farms Inc. established a salt farm at Bolinao, Pangasinan, in 1960.

Accordingly demand of the salt required for the production of caustic soda and chlorine industry are partly provided by the above two companies, and shortage are covered by import. As the salt productions are by solar method, which is largely influenced by the climatic conditions such as rain, typhoon, solar radiation lays, humidity, and temperature, the present production falls short to meet the demand.

Even if the salt production are influenced by climatic conditions, since the year 1969 the salt production is estimated as 210,000-285,000 tons per year. The projected demand of salt in 1974 will be 276,000 tons as shown in the following table, and this amount of demand is supposed to balance with the rated total capacity of the existing salt farm. But at present, shortage of salt supply are pointed up.

Production, Importation, and Consumption of Salt

Year	Local Production		Import		Consumption
	Production (ton)	Amounts (Peso)	Import (ton)	Amounts (Peso)	(ton)
1961	195,111	10,541,186	10,597	169,089	155,708
1962	89,534	5,209,749	6,642	99,310	46,176
1963	85,259	4,774,177	898	61,974	86,157
1964	48,992	2,752,221	672	52,018	49,664
1965	229,880	14,017,935	828	44,280	230,708
1966	138,109	16,331,542	22,896	259,629	161,005
1967	175,142	14,660,023	18,692	241,940	193,834

Source: Bureau of Mines
Central Bank of the Philippines

Consumption Plan of Salt

Year	Consumption (T)
1969	180,000
1970	196,000
1971	214,000
1972	233,000
1973	254,000
1974	276,000
1975	314,000

Source: Office of National Planning,
National Economic Council

6.4.2 Caustic Soda and Chlorine

The first caustic soda and chlorine plant in the Philippines was established at Bais, Negros Oriental by the Compania de Cellulosa de Philippines. Caustic soda and chlorine produced by salt electrolysis was consumed for the production of pulp and paper of the above plant, and minor quantities of hydrochloric acid was produced as the by-product hydrogen and chlorine. The plant was damaged in the wartime, but after the war in 1949 the plant commenced the operation with the capacity 1,800 tons of caustic soda per year. The survey team visited and inspected this pulp and paper plant.

The second salt electrolysis plant was established by the Superior Gas and Equipment Co., (SUGECO), Mandaljong, Rizal. At present the plant is operating with the capacity of 3,000 tons of caustic soda per year, and selling the salt at the domestic market. SUGECO is also producing other chemicals such as chlorine, hydrogen, hypocalcium chloride, bleaching powder, hydrochloric acid, ferric chloride, hypo natrium chloride and calcium chloride.

The third plant producing caustic soda is the Bataan Pulp and Paper Mills Corporation, and the plant started with the small capacity of 3 tons/day. The caustic soda and chlorine produced are supplied to their pulp and paper plant, which is similar with the Cia de Cellulosa plant.

The other plant which supply caustic soda for their own consumption is the La Campana Food Products Inc. In 1962 the plant was operated with small capacity, but extended the plant scale to the production of 2,000 ton per year. International Chemical Industries Inc. established the plant with the rated capacity of caustic soda 12,000 tons and chlorine 10,000 tons per year. The products are solid and liquid caustic soda, liquid chlorine, hydrochloric acid, bleaching powder, ferric chloride, potasium chloride, and hydrogen. At present the company is constructing the caustic soda plant of 60 tons per day.

Mabuhay Vinyl Corporation's (Iligan, Mindanao Island) integrated chemical plant started the operation in 1965, and the present products are caustic soda and chlorine by the salt electrolysis and vinyl chloride (monomer and polymer). In the later period of 1967 the said company extended the capacity by 61%. By the extension of the said company the total rated capacity of the local caustic industries was increased to the annual capacity of 37,000 tons.

In the following table the total supply of caustic soda during the period of 1962 - 1969 is given. This figure includes the total sum of INCHEM, MABUHAY, SUGECO and LA COMPANA, excluding the caustic soda produced by the other two companies for their own use. The increase of caustic soda supply is equal to the sum of production plus importation, the demand of caustic soda in 1967 is estimated at 50,500 tons. Despite of the extension of Mabuhay Vinyl Corporation and International Chemical Industries Inc., the estimated figures show the shortage of caustic soda demanded by local users. The demand of caustic soda is expected to increase at the present rate of growth until 1973.

Hence for the establishment of new bagasse pulp and paper plant the followings are necessary.

1) Stabilization of demand and supply
2) Stabilization of price
3) Reducing the production cost
4) To establish the salt electrolysis plant which supplies caustic soda and chlorine regularly as the important chemicals for the production of pulp and paper in its own plant site

The good example is shown in the case of Bataan Pulp and Paper Mills Corp which owns its own salt electrolysis plant, where they produce caustic soda and chlorine for the production of pulp and paper in the same plant site.

Transition of Demand of Caustic Soda

Year	Local Production (tons)	Import (tons)	Import $	Consumption (tons)
1962	3,400	11,366	658,563	14,766
1963	3,430	18,467	1,413,661	21,877
1964	12,305	17,305	1,991,661	29,655
1965	16,713	8,918	849,016	25,631
1966	19,257	10,077	881,016	29,334
1967	N.A.	12,221	960,029	N.A.
1968	N.A.	10,960		N.A.
1969	37,000	11,526		50,500
1970	37,000			
1971	37,000			
1972	37,000			
1973	37,000			

Source: National Economic Council,
Local Manufacturers

Future Estimation of Demand of Caustic Soda

Year	Demand
1969	50,500 tons
1970	58,900
1971	68,500
1972	80,000
1973	93,200

Source: National Economic Council
O N A P

6.4.3 Demand of Basic Chemicals in the Philippines

The production of basic chemicals such as liquid chlorine and gaseous hydrogen chloride was discussed in the foregoing paragraph. For the further referring to the basic chemicals required for the pulp and paper production followings basing on the data of BOI are pointed out.

1) Liquid chlorine and hydrogen chloride gas
2) Hydrochloric acid
3) Hypochlorate

1) Liquid chlorine

Demand and supply of liquid chlorine at present and future estimation is shown in the following table.

Demand and Supply of Liquid Chroline

(Present production and Future Estimate)

Year	Demand	Supply
1961	1,800 MT	
1962	1,950	
1963	1,923	
1964	1,764	
1965	2,131	
1966	2,038	2,035
1967	2,076	2,076
1968	2,114	2,114
1969	3,619	3,619
1970	3,657	3,657
1971	3,695	3,695
1972	3,733	3,733
1973	3,771	3,771
1974	3,809	3,809
1975	3,847	3,847

Source: Board of Investment (BOI)

Assuming that the plants of Superior Gas and Equipment Co., (SUGECO) and International Chemical Industries are operated at full capacity, the local demand of liquid chlorine will be almost filled.

As to the nominal supply of chlorine during the period of 1966-1975, the data of Economic Research Division, Development Bank of the Philippines is available.

Supply of Chlorine (1966 - 1975)

Year	Supply
1966	2,038 MT
1967	2,076
1968	2,114
1969	3,619
1970	3,657
1971	3,695
1972	3,733
1973	3,771
1974	3,809
1975	3,847

The total production capacity of the plants of Chlorine by International Chemical Industries Inc., and Superior Gas and Equipment Co., amounts to 11,295 MT per year, hence the local demand can be fully filled.

On the other side hydrochloric acid is also the essential chemicals. The demand and supply of hydrochloric acid and projected production is given in the following table.

2) Hydrochrolic acid

Local Consumption of Hydrochloric Acid and Future Demand

Year	Consumption and future demand
1966	8,113 MT/Y
1967	9,108
1968	10,104
1969	11,099
1970	12,095
1971	13,090
1972	14,086
1973	15,081
1974	16,077
1975	17,071

In 1969 National Bank classified hydrochloric acid in two kinds.

a. Chemical pure
b. Industrial use

In 1969 the Philippines imported 227,620 kg of hydrochloric acid (chemical pure) and 202,676 kg (Industrial use) from the Republic of China.

Following table shows the local demand (projected) of hydrochloric acid.

Local Demand (planned)

Year	Demand (ton)
1966	11,500
1967	12,900
1968	14,400
1969	16,100
1970	18,000
1971	20,000
1972	22,500
1973	25,200
1974	28,200
1975	31,500

Source: Local Manufacturers
National Bank of the Philippines

6.5 Prospect of the Integrated Industrial Area of Iligan

Irigan Area is located at the southern part of Philippines, the rainy area, and forms one of the so called integrated industrial combinat, where Iligan City located at the middle.

Present survey covered this industrial zone of Iligan, but the survey of the factories of steel and iron, cement, and fertilizers are excluded from the objective of the survey.

Iligan City is located about 100 km from Cagayan Airport, and surrounded by a good port of Iligan Bay, and favored with abundant water resources of Agus River.

With this favored natural and geographical conditions, the Maria Cristina hydro electric power station and Iligan industrial estate were developed.

The Agus River originates in the Lanao-Bay (Natural Lake), and flows affluently by the balanced rain falls through the year.

The Lanao Bay is located at 701 m height and possess the area of 350 km^2, the flow passage of the Agus River is 38 km long and of sharp inclination.

Utilizing this natural topographical condition, 720 MW of hydro electric power generation is now planned.

Maria Cristina Hydro Electric Power Station is located at 3 km upper reach from Iligan, and four units of electric power generator (electricity supply; 150 MW) are installed in the station and supplying the electric power to the industrial zone.

Iligan industrial zone is supplied with electric power comparatively cheap, and the industries such as calcium carbide, fertilizers, steel and iron, cement, flour, paper, and chemical industry of salt electrolysis were invited for the establishment of factories and are operating at present.

The survey team visited following three plants:

a. Maria Cristina Hydro Electric Power Station
b. Mabuhay Vinyl Corporation
c. Rustan Pulp and Paper Mills Inc.

1) Marian Cristina Hydro Electric Power Station (The Sixth Station)

Location	: Maria Cristina, Iligan City		
Water Source	: The Agus River		
Capacity	: Total Electric Power Supply (capacity)		
	150,000 KW	25,000 KW	2 units
		50,000 KW	2 units
Electric Power	: 138,000 V, 60∞, 3 - phase		
Completion	: Starting of construction		August, 1950
	No. 1 unit put into operation		May, 1958

2) Rustan Pulp and Paper Mills Inc.

Location: : Bomaria Cristina Lanao del Norte

Capacity :
- a. Lauan Wood — Kraft Pulp (U-KP)
  - M/D Digester — 75 t/day per unit
  - pulp source ..... Lauan wood waste
- b. Board making machine — 1 unit 105 t/day under construction
  - Corrigated medium — 65 t/day
  - Board and liner — 105 t/day
- c. Abaca bleached soda pulp (B-AP)
  - Groved Digester — 2 units 15 t/day capacity

Water source:	:	The Agus River
Raw material wood:		The area where Lauan wood is gathered is located in the region of 100 km around the mill, and there are three collection areas.
Plant area	:	24 ha.
Operation	:	Lauan U-KP plant stopped its operation. Board m/c is under construction. Only Abaca plant was working at the time of our visit.
Man-power	:	500 persons

3) Mabuhay Vinyl Corporation

This plant is producing caustic soda, chlorine, and hydrogen by electrolysis of salt and acetylene was supplied from the adjoining Maria Cristina Factory to make vinyl chloride monomer and polymer, and it is thought to be one of the best plants operating with integrated capacity of this kind of chemical industries in the Philippines.

The survey team visited the plant and felt the plant noteworthy as one of the first petro-chemical plants using the low cost electric power generated in the Iligan Area.

a. Caustic soda plant and vinyl chloride plant

Production	:	Caustic soda	about 680 MT/month
		Hydrochloric acid	about 560 MT/month

Chlorine produced is reached with acetylene to make vinyl chloride monomer, and then monomer polymer is produced.

Man-power	:	250 persons
Vinyl chloride production:		about 860 MT/month (monomer)
Vinyl chloride production:		about 820 MT/month (polymer)