REPORT
ON
THE SURVEY OF THE WATER WORKS

DUNGUN AND KEMAMAN DISTRICTS
MALAYSIA

March 1968

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

PREFACE

At the request of the Malaysian Government, the Japanese Government has decided to undertake the investigation of the construction project of water works in the districts of Dungun and Kemaman, Trengganu Province, Malaysia, and has commissioned the Overseas Technical Cooperation Agency to carry out the task.

In view of the importance that the water supply services will have in the promotion of welfare and particularly in the improvement of environmental sanitation of the inhabitants of Dungun and Kemaman, the Overseas Technical Cooperation Agency has sent a six-member survey team headed by Dr. Tamon Ishibashi for a period of 40 days, from August 21, 1967, to September 29, 1967. Fortunately, with the Malaysian Government's cooperation, the team was able to accomplish their mission without complications, and finished the investigation of the plan for construction of water works, including surveys, borings, and the testing of the quality of water.

In Dungun, the River Dungun which flows through the district, was chosen for a source of water and in Kemaman, the River Kemaman which flows through the town of Chukai, and based on this, a survey was carried out with a plan for the most economical water supply and distribution facilities in mind.

The team made an overall and systematic study of the findings of the above survey, and took into full consideration the opinion put forth by the Malaysian Government. Based on this study, a preliminary design for complete facilities, calculated construction costs, operation and maintenance expenses and an annual estimated revenue and worked out a financial plan.

If this report should prove helpful concerning the construction of water works in Malaysia and contribute to the improvement of the welfare of the nation, it would be a matter of congratulation for the economic interchange and friendly relationships between the two nations.

March 1968

Shinichi Shibusawa
Director General
The Overseas Technical Cooperation Agency

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Abbreviation

BC	Bronze Casting
FC	Gray Iron Casting
CIP	Cast Iron Pipe
GSP	Carbon Steel Pipe
VP	Vinyl Pipe
PVC	Polyvinyl Chloride
SUS	Stainless Steel

Part 1. Outline of Survey

According to the "Official Year Book, 1965" published by the Malaysian Government in 1967, the total number of population of Malaya was estimated at 7,900,000 in 1964. Against this population, there were 183 water works, large and small, which served 3,750,000 people, or 48% of the total number of population. The Province of Trengganu had an estimated population of 350,000 in 1864, of which the population supplied was 40,000 or 11.5%.

The Malaysian Government has a plan to construct a water works in Dungun and Kemaman, the towns largest in population next to Kuala Trengganu in the Province of Trengganu. A survey was carried out as early as 1964 by the Bolton Hennessay Cogan & Associates Consulting Engineers. Recently a request was made of the Japanese Government to carry out a more detailed survey.

In response to this request, the Japanese Government sent a survey team consisting of the following members for a period of 40 days from August 21 to September 29, 1967. The purpose of this team was to conduct a survey to work out an estimated demand for water, to determine water sources and to design required facilities and, based on the survey results, to prepare a feasibility report to be submitted to the Malaysian Government.

Organization of the Survey Team.

Head: Tamon Ishibashi, Professor of the Faculty of Technology, Tokyo University.

Members: Osamu Tsuda, Pacific Consultants, Ltd.
Takashi Matsumura, Kurita Engineering Co. Ltd.
Munemitsu Hayakawa, Ditto.
Shiro Takahashi, Ditto
Yoshio Furuya, Pacific Consultants, Ltd.

Sampei Toki, Overseas Technical Cooperation Agency

Prior to carrying out field surveys, a request was made of the survey team by the Malaysian Government authorities that attention be given to the following matters:

(1) Careful investigation be made in working out an estimated population supplied.

(2) Careful study be made of per-capita water requirement.

(3) Actual conditions of the locality be taken into full account in determining water requirements for fire fighting.

(4) Study be made so as to minimize per-$1m^3$ cost of construction.

With the above four points in mind, the survey team chose as a source of water intake in the town of Dungun the River Dungun which flows through the town and in Kemaman the River Kemaman which flows through Chukai Town and proceeded with their surveys and boring operations, testing of water quality and collection of data to establish a plan for the most economical supply and distribution facilities.

The schedule of the survey was as follows:

Date	Day of Week	Activities
Aug. 21, 1967.	(Mon.)	Left Tokyo.
23, "	(Wed.)	Reached Kuala Lumpur
24, "	(Thur.)	Visited the Japanese Embassy, EPU & PWD, to inform them of their arrival and make arrangements.
25, "	(Fri.)	Inspected water supply facilities in the city of Kuala Lumpur.
26, "	(Sat.)	Left Kuala Lumpur and arrived in Trengganu.
27, "	(Sun.)	Visited PWD and inspected water supply

			facilities in the city of Trengganu, Moved to Dungun.
Aug.	28, 1967	(Mon.)	In the area of Dungun, Investigation and survey of the proposed points, collection of data, and discussion with persons concerned.
Sep.	8, "	(Fri.)	Establishment of a basic plan.
	9, "	(Sat.)	Moved to Kemaman. Announced the team's arrival and made arrangements with PWD.
	10, "	(Sun.)	In Kemaman area, Investigation and survey of the proposed points, collection of data, and discussion with persons concerned.
	17, "	(Sun.)	Establishment of a basic plan.
	18, "	(Mon.)	Paid a visit to Kemaman, Dungun and PWD.
	19, "	(Tue.)	Collection of additional data. Discussion with people concerned.
	26, "	(Tue.)	Preparation of an interim report.
	27, "	(Wed.)	Visited the Japanese Embassy, EPU, & PWD to say goodbye and presented the interim report.
	28, "	(Thu.)	Left Kuala Lumpur.
	29, "	(Fri.)	Left Bungkok and arrived in Tokyo.

Upon completion of the investigation of the proposed sites, the survey team collected and compiled the findings of the investigation and presented an interim report to the Malaysian Government authorities and gave an explanation of it. On this occasion, the Government authorities made a request of the team on the following two points :

(1) From 7:30 P.M. to 10:00 P.M. every day, the peak of power consumption is reached and it is apprehended that N.E.B. (National Electric Board), giving priority to home consumption of power, may suspend transmission of power for water supply for certain hours. The worst possibility of hours of tide sensitiveness following this suspension of power transmission would be taken into consideration in establishing a plan.

(2) Comparative study should be made between suspension of water supply for tide-sensitive hours and construction of a storage reservoir for a 24-hour continuous purification.

Concerning the first demand, the team expressed its view that a plan to satisfy the worst condition will see a remarkable increase in the cost of construction, resulting in a higher unit price of water than otherwise, and that power supply for the water supply, which is a public utility, should be separately considered by N.E.B. with the object of supplying cheap power by expanding its power generation capacity (facilities).

The Malaysian Government authorities understood the purpose of the team's explanation, and sent us a reply to the following effect on 16 October, 1967.

The N.E.B. will supply required power for the water works on an uninterrupted 24-hour basis but the power rates per KW. are to be 21 cents from 6:00 P.M. to 9:30 P.M. and 7.5 cents for the rest of the day.

After its return to Japan, the team made a comprehensive study of the results of its survey on the site and the Malaysian Government authorities' opinion, with due regard given to both. Based on this study, the team worked out a preliminary design for all facilities relevant to the plan for building water works in both areas, Dungun and Kemaman, and by calculating construction costs, maintenance and management expenses and an estimate of annual revenue, worked out a financial program.

In conducting the present survey, the team owed much to the cooperation of the following persons.

Kuala Lumpur :

Mr. Sulaiman bin Abdullah, Secretary, Economic Planning Unit (E.P.U.)

Mr. Chong Koon Kee, Assistant Director (Water supplies) Public Works Department (P.W.D.)

Trengganu :

Tan Sri Ibrahimbin Fikri, Mentri Besal, Trengganu State.

Mr. S. Theravian, State Engineer, P.W.D.

Mr. Yong Chiew Yee, Water Works Engineer, P.W.D.

Mr. S. H. Thevaraj, State Engineer, D.I.D.

Dungun :

Mr. Bararuddin, District Officer.

Mr. Fong Chien Yee, District Engineer, P.W.D.

Dr. Scharenguivel, Doctor, Dungun Hospital.

Mr. Che Mat, Officer in charge, National Electric Board.

Mr. Noordin Hitam, Balai Bomba

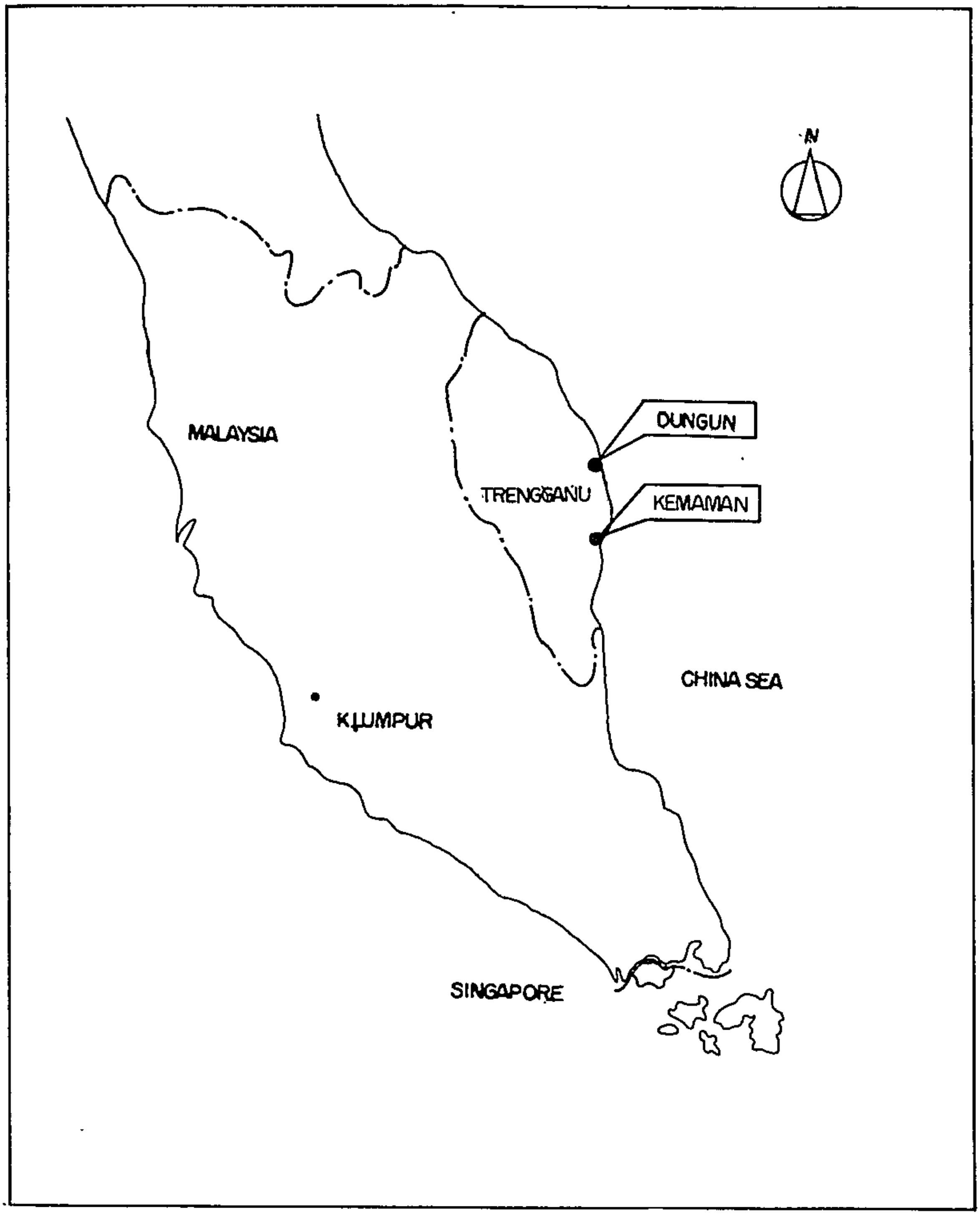
Mr. Gavan Newman, B.E., Joint Managing Director, Eastern Mining & Metals Co., Ltd. (E.M.M. Co.)

Mr. J. Gritching, B.E., Civil Engineer, E.M.M. Co.

Kemaman :

Mr. Hasimbin Sulaiman, District Officer.

Mr. Ho Kee Chai, Ass. District Engineer, P.W.D.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MALAYSIA
TRENGGANU
DUNGUN
KEMAMAN
CHINA SEA
K.LUMPUR
SINGAPORE

Part II. Conclusion and Suggestion

This was the first case in history that a Japanese survey team for water works was sent by the Japanese Government to Malaysia. At first the team encountered more or less unfamiliar things, but with the whole-hearted cooperative assistance extended by the Malaysians Government the team was able to tackle the task by employing all technical knowhow on water works engineering Japan possesses.

The district entrusted to the team for survey lies on the east coast of Malaysia and, compared with the developed districts on the west coast, leaves much room for future development. With a small population at present, the district shows a very low rate of diffusion of water supply.

Of the two districts of Dungun and Kemaman, which the team surveyed at this time, a preliminary survey had once been made by Bolton Henessey-Cogan & Associates Consulting Engineers in 1964. Our survey was, therefore, a re-survey made in more detail at the request of the Malaysian Government.

In general, construction of modern water supply facilities in a small local city which is partially developed tends to be relatively costly, with a which results in relatively large operation and maintenance expenses. Dungun and Kemaman are no exception to this. We therefore strictly faced reality and tried to prepare a right report.

Special features which can be cited as common to all districts on the east coast of Malaysia from the view point of construction of water works are as follows:

(1) The rivers run slowly near the estuaries and have many meanderings.

(2) The districts are characterized by monsoon seasons, which

are also seasons of flooding.

(3) Along the rivers from near the estuaries to midway upstream, there dominate swamps where water stays which contains organic matters developing from decaying vegetable matter and is not good to drink.

(4) The water of any river is good to drink in itself in terms of quality, but as it is tide-sensitive at the extreme upstream, the water becomes saline during the tidal hours.

(5) Shallow wells do not give water of good quality and as the soil is not of alluvium, deep wells fail to give a required quantity of water.

(6) Without any proper port of landing, all materials will have to be carried over the mountains from the west coast.

(7) The existing power generation plant cannot be depended upon wholly because its capacity is low.

These special conditions were taken into full consideration.

If water supply facilities are constructed based on this report, the inhabitants of the two districts will be happier indeed to find themselves in a highly improved sanitary environment. The undertaking will also lead to a better relationship between Malaysia and Japan.

Chapter 1. Dungun

With an annual growth rate of population set at 2 per cent, the population to be served will be 20,400 in 1980 and 25,400 in 1995. With a per-day, per-capita planned water quantity set at 29 gallons in the plan for 1980 and 34 gallons in that for 1995, water treatment facilities are to have a capacity of 622,400 gal/D in 1980, including the water demand of the treatment works, and in 1995 after expansion, 908,500 gal/D.

There would be no question concerining the construction of an intake tower if it were to be built on the upper stream where no tidal effect is felt, but it would be very expensive to build one there. The site was therefore chosen as near the city area as possible. The river is of course tide-sensitive at this point, but suspension of intake for 3 hours at the most during the tidal hours will be enough to prevent salt infiltration.

The intake tower, (excluding pumps), rising main, chemicals, flush mixer, filtrate tank, supply main and distribution main were so arranged that there would be no need for expansion in the future.

Total cost of construction was estimated to be about ¥220,000,000 (something less than M$1,800,000) provided all equipment was to be imported from Japan, and the term of construction would be 2 years.

The water charge of M$1.00 per 1,000 gallons, as the Malaysian Government wants it to be, forecasts red figures financially. As a measure to counter this, it will be necessary to raise the charge and to construct power generation facilities for the exclusive use of the water treatment plant which was given in the alternative plan.

Chapter 2. Kemaman

With the annual growth rate of population set at 4.2 per cent, the population to be served will be 33,200 in 1980 and 46,400 in 1995. With a per-day, per-capita planned water quantity set at 30 gallons in the plan for 1980 and 35 gallons in that for 1995, water treatment facilities are to have a capacity of 1,056,000 gal/D in 1980, including the water demand of treatment works and in 1995 after expansion, 1,722,000 gal/D.

There would be no question concerning the construction of an intake tower if it were to be built on the upper stream where no tidal effect is felt, but it would be very expensive to build one there. The site was therefore chosen as near to the city area as possible. The river is of course tide-sensitive at this point, but suspension of intake for 6 hours at the most during tidal hours will be enough to prevent salt infiltration.

The intake tower (excluding pumps), rising main, chemicals, flush mixer, filtrate tank, supply main and distribution main were so arranged as to fullfil the requirement in 1995 and there would be no need for enlargement in the future.

Total cost of construction was estimated to be a little less than ¥340,000,000 (or something above M$2,580,000) provided all equipment was to be imported from Japan. The term of construction would be 2 years.

The water charge of M$1.00 per 1,000 gallons, as the Malaysian Government wants it to be, forecasts red figures financially. As a measure to counter this, it will be necessary to raise the charge and to construct power generation facilities for exclusive use of the water treatment plant which was given in the alternative plan.

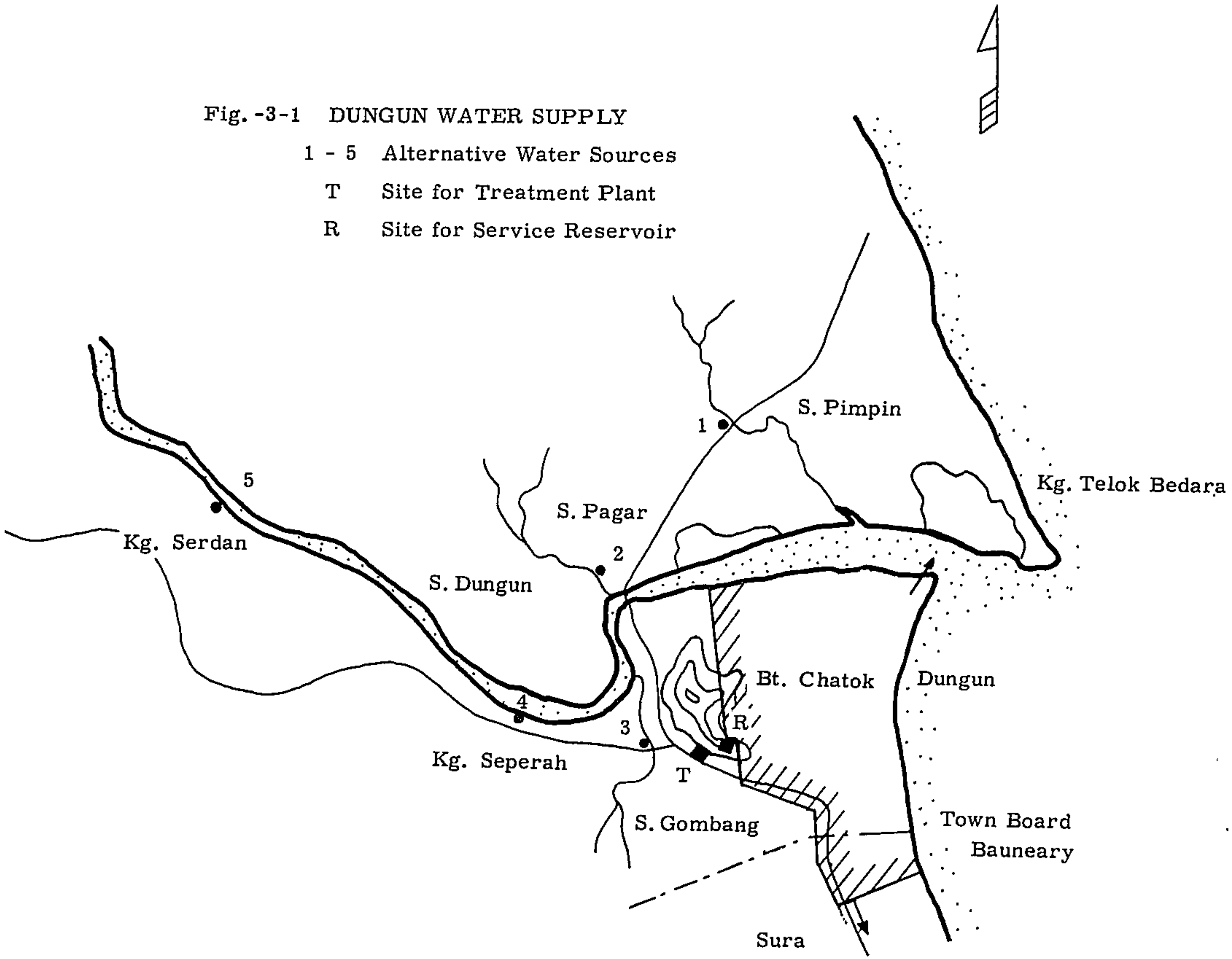
DUNGUN

Fig. -3-1 DUNGUN WATER SUPPLY

1 - 5 Alternative Water Sources

T Site for Treatment Plant

R Site for Service Reservoir



Part III Water Supply Plan in Dungun Area

Chapter 1. General Outline

Dungun is situated on National Highway No. 3, which runs along the east coast and on the estuary of the River Dungun, and is about 50 miles south of Kuala Trengganu, the capital of Trengganu State and about 40 miles north of Chukai.

With governmental offices and buildings such as the Dungun District Office, school buildings, hospitals, a police station, a fire-brigade station, and banks, hotels, rest-houses and movie theaters, as well, it is the center of politics, economy and communication in the Dungun District.

What has been responsible for the development of this town is the Bukit Basi iron mine 16 km west of the town. Among other industries are agriculture, forestry and fishing but very little can be said of the manufacturing industry.

The Bukit Besi iron mine was developed by a Japanese firm before World War II, and after the war grew into the largest iron mine in Malaysia. It has some 4,000 employees, contributing to the prosperity of Trengganu State.

The mine had turned out 3,000,000 tons of iron ore annually until recently when the deposits reached a marginal point, reducing the annual output to 1,500,000 tons. Unless new deposits are found, the time is approaching when it will be impossible to work on a paying basis.

The post-war development of the mine was so remarkable that the population of the Dungun District rapidly increased by about three times from 4,256 in 1947 to 12,515 in 1957. Seeing that in the same ten years the total population of Malaya showed an increase of 28% and that of Trengganu State

23%, it was quite astounding.

Seeing that the Bukit Besi Mine is now on the decline as stated before and no prospect is in sight of an epock-making development in any other industry, it is easily foreseeable that an increase in the population in the next ten years will be smaller in this district than Malaya as a whole or Trengganu State.

Chapter 2. Outline of the Water Supply Plan

2-1 Supply Areas

As is shown in Fig. 3-1,the supply area will be limited to a part of the Dungun Town Board and Sura district, and Kg. Telok Bedara on the north side of the Dungun River, and a part of the Dungun Town Board will be excluded from the 1980 plan. This is due to the areas' small population which is only 1,600 at present, and because the cost to lay 700 yardlong subterranean pipes across the Dungun River to reach the sparsely populated area, would greatly decrease the economic effect of the whole water supply plan.

Other areas were also excluded in order to increase the economic effect of the plan. The excluded areas are small villages along the highway leading to Bukit Besi, and along the third national highway from Sura to Kg. Batu Lima.

However, the population of the Kg. Telok and Sura districts is included in the estimated amount of water supply of 1980, and all the necessary intake and treatment pipes and distribution mains are included in the plan so that it will not impede the plan, even if the water supply to these areas should begin before 1980.

2-2. Population To Be Served

It is difficult to estimate the population of 1967 based on the statistics of 1947 and 1957. We used the figure presented by a Dungun District Officer as the most reliable data. According to this figure, the population of Dungun Town Board is 14,000.

The rate of the future population increase is expected to be low. Mines in Bukit Besi do not seem to greatly influence the population increase. The District Officer thinks, and we totally agree that though some population shifts can be expected by future agricultural developments in provincial areas of the Dungun District, a large increase in the Town Board population is not expected.

Accordingly, we estimated the rate of the Town Doard population increase per year at 2 percent, which is a little lower than other Malayan districts and adding to it the estimated population of Sura area, and we determined the water supply population of 1980 to be 20,400. That of 1995 is estimated, by adding the 2 percent of the estimate of the increase rate per year, at 25,400.

2-3 Expected Supply

The P.W.D. statistics of 1965 show the daily water consumption per person in Malaya as follows:

Average in the whole of Malays	30.86 Gallons
Average in Perlis, Pahang, and Trengganu States	26.54 Gallons
Average in Kuala Trengganu	28 Gallons

The above figures cover the water consumption of both provincial areas and city districts. And with the exception of the Kuala Trengganu average, the figures are the average water consumption of those areas where various water supply plants, large and small, old and new, are installed.

In Dungun Town Board there are no industries that require a large amount of water at present, and the probability of development of this sort of industry in the near future seems to be very low. Most of the inhabitants are engaged in small-scale fisheries; but there is little indication of construction in the near future of factories requiring large amounts of water such as for the manufacturing of ice, frozen foods, and canning. There is no drainage system installed at present, and it does not seem likely that one will be constructed in the near future.

Taking these conditions into consideration, it was felt that a too-large water supply plan would be uneconomical. It was decided that the daily water consumption per person is to be 29 gallons under the 1980 plan; and 34 gallons under the 1995 plan. That is:

In 1980	29G x 20,400 (population)	= 591,600G.
In 1995	34G x 25,400	= 863,600G.

The first objective of our plan is to procure the planned water supply of 1980 with good economic effects based on reality. The 1980 plan is made in consideration of facilitating the future 1995 expansion.

Designing distribution mains for the rural districts of the supply area. The estimated daily water supply per person was 18 gallons, and the pipes were designed to produce better economic effects.

Chapter 3. Water Source

3-1 Standards of Water Quality

To determine the source of water supply, the criteria of the water quality must be established primarily. However, in the Federation of Malaysia, standards have not yet been established. On August 24th 1967, Malaysian authorities and the investigation committee held their first meeting, at which time Mr. CHONG, Ass. Director P.W.D., requested the criteria to be followed be the standards of the W.H.O (World Health Organization). Our survey and all schemes based on our survey should, accordingly, be such as well satisfy the standard* of W.H.O. as shown in Table 3-1.

* W.H.O ; International Standards for Drinking Water, Page 206, (1963), Geneva.

3-2 Water Sources and Intake Points

3-2-1 Selection of Sources

The possible sources in this catchment area are the Dungun Main River, the Dungun Tributaries and the ground water.

As for wells, members of P.W.O. made eight boring tests* in 1963, and this time a party of this investigation studied the question on the spot. In view of the results so achieved, it was made clear that spring water from shallow wells contains a large amounts of sulphate ion, chloride ion and iron, and that it holds only poor quantity. Next, deep wells were examined · the geological feature was estimated not to have alluvium which contains a good deal of adequate water. Consequently, wells were estimated to be unsuitable for the sources of supply.

* Bolton Hennessey Cogan & Associates ; Report on A Proposed Water Supply to Dungun, P6.

Consequently, the most suitable intake point had to be found for in surface water ; the five points shown in Figure 3-1 were examined from a

Table 3-1 Water Quality Standards for Drinking Water

	W.H.O. Standard	Japan Standard	U.S.A. Standard	W.H.O. (in Europa) Standard	England Standard
Coliform groups		never detected in 50 ml.	Positive samples: not more than 10% in a month	Not more than 15 samples in 100 samples (100ml.)	There are no particular standards.
Number of bacteria		Not more than 100 in 1ml.			
Odor		Must not be	3*		
Taste		abnormal	must not be abnormal.		
Colour		5°	150°		
Turbidity		2°	5°		
Total solid		500 ppm	500 (1,000) ppm		
pH value	7.0-8.5 (6.5-9.2)	5.8-8.6			
Total hardness	100-500 ppm *	300 ppm *		100-500 ppm	
Potassimn permanganate consumed.	10 ppm	10 ppm			
Chloride ion	200(400) ppm	200 ppm	250 ppm	350 ppm	
Sulphate ion	200(400) ppm		250 ppm	250 ppm	
Ammonia Nitrogen	0.5 ppm	never detected		0.5 ppm	
Nitrite Nitrogen		at the same time			
Nitrate Nitrogen	40(80) ppm	10 ppm	45 ppm	5 0 ppm	
Lron	0.3(1.0) ppm	0.3 ppm	0.3 ppm	0.1 ppm	
Manganese	0.1(0.5) ppm	0.3 ppm	0.05 ppm	0.1 ppm	
Fluoride	1.0(1.5) ppm	0.8 ppm	0.6-1.7 ppm	1.5 ppm	
Lead	0.1 ppm	0 1 ppm	0.05 ppm	0.1 ppm	
Arsenic	0.2 ppm	0.05 ppm	0 01(0.05) ppm	0.2 ppm	
Selenium	0.05 ppm		0.01 ppm	0.05 ppm	
Hexavalent chromium	0.05 ppm	0.05 ppm	0.05 ppm **	0.05 ppm	
Copper	1.0 ppm	1.0 ppm	1.0 ppm	0.05 ppm	
Zinc	5.0(15 0) ppm	1.0 ppm	5.0 ppm	5.0 ppm	
Phenol	0.001 (0.002) ppm	0.005 ppm	0.001 ppm	0.001, ppm	
Cyanide	0.01 ppm	never detected	0.01 (0.2) ppm	0.01 ppm	
Mercury		never detected	0.05 ppm		
			1.0 ppm		
Cadmium			0.01 ppm	0.005 ppm	
A.B.S.			0 5 ppm	take care of the concentration	
Radioactivity	Dray 10^{-a} μc/ml Bray 10^{-8} c/ml		Ra. 225. 3μμc/l ayear Sr. 90, 10μμc/l a year Total B, 100μμc/l a year	Dray 1μμc/l Pray 10μμc/l	
Organic Phosphorus		never detected			
Free residual chloride		not under 0 1 ppm	0.05-0.1 ppm		
Magnesium	50(150) ppm				
Calcuim	75(200) ppm	* as $CaCO_3$	* as No_4		
	( ): when unavoidable * as $CaCO_3$ * as NO_3	** changing to 0.05 ppm *** changing to 0.5 ppm	** sexivalent ( ), when unavoidable. There are others Such as Silver, 0.05 ppm Activalted Carbon , 0.2 ppm Chloroform extraction quantity, 0.2 ppm.		

stand-point of reasonability for sources.

(a) No. 1 - No. 3

Considering their locations, points No. 1 thru No. 3 were found to be favourable intake points, if the sources were expected to have enough quantities and proper qualities with the exception of salinity for the raw water of supply. Point 3 was found to have a particularly favourable location because of its nearness from the urban areas. On the other hand, the tidal action might influence the point unexpectedly, and the salinity would increase accordingly. However, the river is so narrow that the flow-of sea water could easily be prevented if a tide gate were constructed. The samples collected at No. 3 were redish brown in color and transparent, and the results analysed are shown in Table 3-2. Indicating that the samples were high in colour and C. O. D. values ; therefore, they would contain much organic matters. It also indicates that they were low in P^H values and rather high in iron concentrations. So it would not be a favourable source of supply from the view point of raw water. Table 3-3 shows the results of the coagulation tests. It indicates that not only was the water difficult to purify, but also it would never satisfy the W. H. O standards particularly in colour.

According to the results obtained above, points No. 1 thru No. 3 were proved to be unsuitable for the source of supply.

Table 3-2 Chemical Analysis of Samples of S. Gombang Alternative Site
Number and Location of Sampling
No. 3, Highway Bridge to Bukit Besi
Date & Time of Sampling
09. 30 of 30th. August, 1967

Appearance	Brown, Transparent
Color	150
pH	5.0
Chlorides as Cl	25

Iron as Fe	2.0
Chemical Oxygen Demand as O 30 minutes 100°C	179

All Values in Parts per Million

Testing method; based upon JIS KOIOI

Table 3-3

Coagulation Test

Run	1	2	3	4	5
Alum as 14% Al_2O_3	40	40	40	40	40
Sodium Hydroxide as $CaCO_3$	0	17.5	27.5	17.5	17.5
pH	4.2	5.7	6.9	5.7	5.7
Kaoline	0	0	0	10	0
S-250*	0	0	0	0	0.3
Floc Formation	++	++++	+	+++	
Filtrate after Coagulation					
Color	60	25	40	25	
Iron as Fe	0.5	0.3			

All Values in Parts per Million

*Commercial Name of Polyelectrolyte Coagulant.

(b) No. 4, No. 5

(No. 4 ; Kg. * Seperah, 4 miles upstream from the estuary.

No. 5 ; Kg. * Serdan, 7 miles upstream from the estuary.)

Table 3-4 shows the qualities of the water which was taken at 14:00, 29th August, 1967 near Kg. Seperah. As shown in the table, this sample proved to be low in alkalinity, hardness, iron contents and organic matters, though high in turbidity.

Table 3-4

Chemical Analysis of Samples of S. Dungun.

Alternative Site Number and Location of sampling No. 4.

The Ferry at Kg. Seperah

Date & Time of Sampling 14.00 of 29th. August, 1967.

Appearance.	Brown
Water Temperature (°C)	27
Turbidity	50 - 70
PH	6.8
M-Alkalinity as $CaCo_3$	6.0
Chloride as cl	4.0
Total Iron as Fe	0.8
Total Hardness as $CaCO_3$	4.0
Chemical Oxygen Demand (30 minutes 100°C)	7.5
Ammoniacal Nitrogen	+
Nitrite Nitrogen	+

All Values in Parts per Million

Consequently, this water would be available to municipal and industrial water provided that the contamination caused by tidal flow could be prevented. Coagulation tests were made on the sample and the results are shown in Table 3-5. It shows that the water could be purified to satisfy the W.H.O standards with considerable ease.

* The abbreviation for "Kampong", which corresponds to "Buraku, (or Village)" in Japan.

Table 3-5

Coagulation Test

Run	1	2	3	4
Alum as 14% Al_2O_3	10	15	20	30
PH after Alum Dosing	6.0	5.2	-	4.7
Sodium Hydroxide as $CaCO_3$	4.4	7.0	9.8	15
pH After sodium hydroxide Dosing.	6.9	6.8	6.8	6.9
Floc Formation	+	++	+++	++++
Filtrate after Coagulation Turbidity	2>	2>	2>	2>
Color	8-5>	2-3>	2-3>	2-3>
Total Iron as Fe		0.3>		
Chemical Oxygen Demand as O (30 minutes 100°C)		5.5		

All Values in Parts per Million

3-2-2 Determination of the Intake Point

(a) Tidal Level, Rainfall and Water Qualities.

In the preceding section, it was proved that the water of the Dungun River is available to municipal and as industrial water if the salinity could be prevented.

Therefore, we studied tidal influence on the water of the Dungun River during our field investigation ; a continuous investigation of the water quality and the water level was made at points No. 4 and No. 5 on the 3rd of September 1967, when the tidal level at Kuala Dungun reached its monthly maximum. The result is presented in Figure 3-2.

It indicates that the water at point No. 4 was evidently influenced by the tide and that the chloride ion concentration exceeded 200 ppm for a period of about two hours. The water at point No. 5 was proved not to under the tidal influence. Subsequently it may be concluded that the maximum tidal reach of the Dungun lies between points 4 and 5.

FIG-3.2 TIDE HIGHT, CHLORIDE ION V.S. TIME (SEP. 3,' 67, KG. SEPERAH, KG. SERDAN)

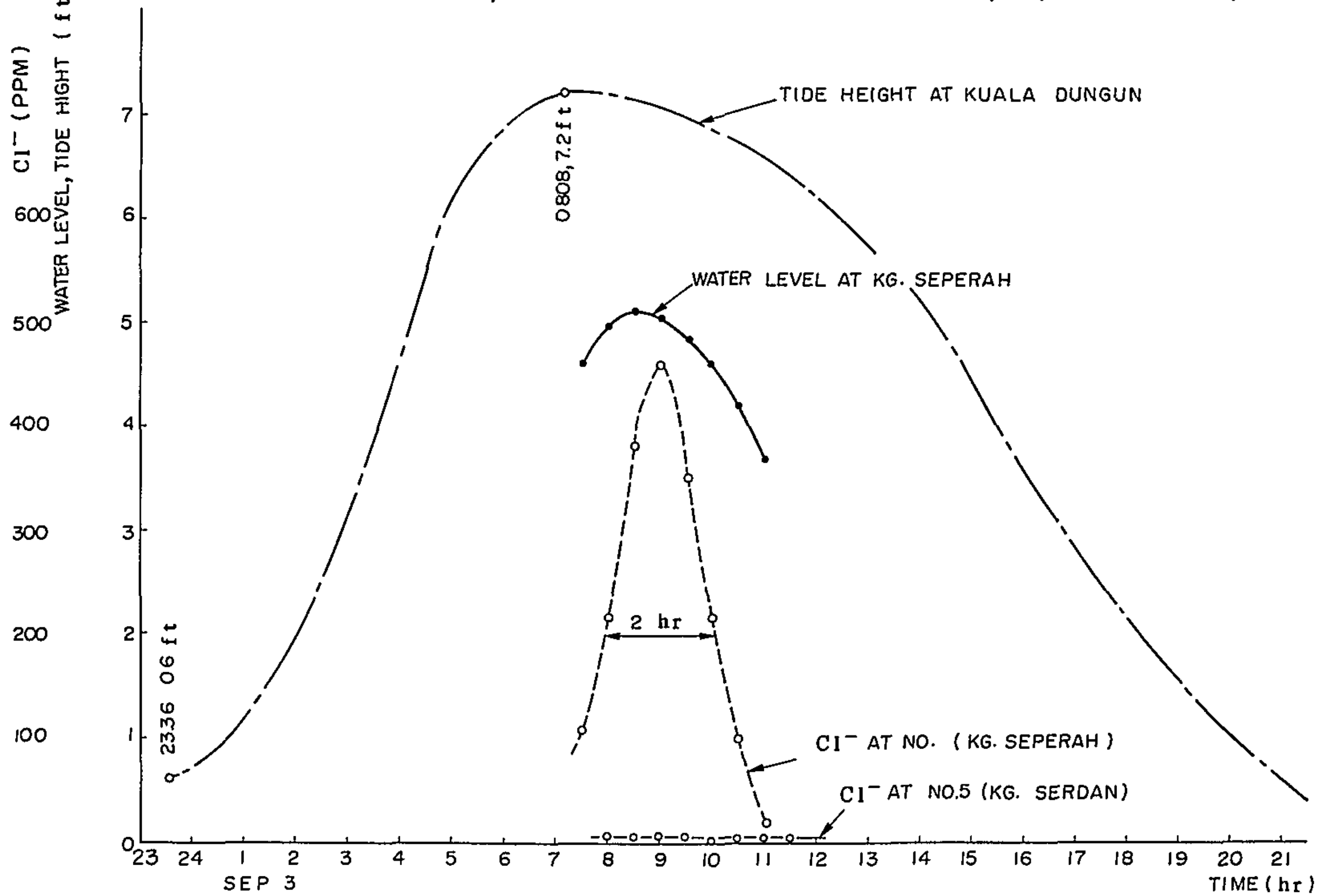


Table 3-6: Monthly Rain Fall-Bukit Besi

Years of	January	February	March	April	May	June	July	August	September	October	November	December	Total
1950			10.58	17.36	10 62	15.68	5.21	17.87	16.31	12.37	15.24	23.01	144.25
1951	22.02	10.10	7.16	9.90	12.79	2.51	9.14	10.91	15.90	11.87	15.96	20.97	149.23
1952	11.92	16.33	5.40	9.33	8.33	12.59	8.25	11.94	9.45	16.22	13.81	13.15	136.72
1953	24.23	15.26	8.62	6.32	8.43	4.44	9.62	7.11	16.34	6.02	17.90	27.15	151.44
1954	19.44	4.35	15.26	3.71	8.54	13.59	9.95	15.11	17.16	13.06	25.93	42.18	188.28
1955	20.51	4 27	1.86	12.06	14.48	8.62	16.80	8.47	9.12	13.87	16.62	18.10	144.78
1956	18.94	6.86	9.32	9.08	15.24	7.30	11.81	14.78	18.58	13.94	27.73	40.99	194.57
1957	10.41	5.77	8.62	4.83	9.67	11.39	7.31	8.39	18.27	15.24	24.73	43.23	167.86
1958	10.08	8.64	3.00	0 54	5.17	8.03	5 12	11.76	9.64	18.26	34.31	7.45	122.00
1959	9.41	2.97	13.35	7.06	4.02	8.24	7.03	10.73	9.12	16.80	22.93	14.24	125.90
1960	19.36	8.64	2.21	5.80	13.35	8.33	11.65	5.47	17.33	9.76	13.09	34.11	149.10
1961	16.15	7/32	11.44	13.36	12.68	7.08	8.11	19.63	11.50	9.71	23.54	50.62	191.14
1962	13.79	3.02	22.92	4.22	8.11	7.89	4.08	7.72	12.77	14.04	18.15	32.76	149.47
1963	16.56	4 38	2.02	1.51	6.08	3.95	11.83	13.94	14.47	8.46	17.85	26.74	127.79
1964	11.97	25.01	6.77	5.49	16 40	8.85	8.68	8.69	12.22	21.39	18 11	26.71	170.29
1965	1.59	5.40	3.89	6.75	10.93	13.61	10.83	5.71	10.95	15.84	27.29	42.55	155.34
1966	31.08	15.39	16.80	7.42	15.08	7.44	11.29	12.82	6.83	18.41	14.65	25.36	182.57
1967	39.78	20 01	7.98	8.02	10.06	6.00	9.66	16.11					
1968													
Average	17 48	9.63	8.78	7.34	10.58	8.80	9.22	11.51	13.29	13.84	20.46	28.78	159.71

FIG - 3.3 MONTHLY H. H. W & L.L.W.

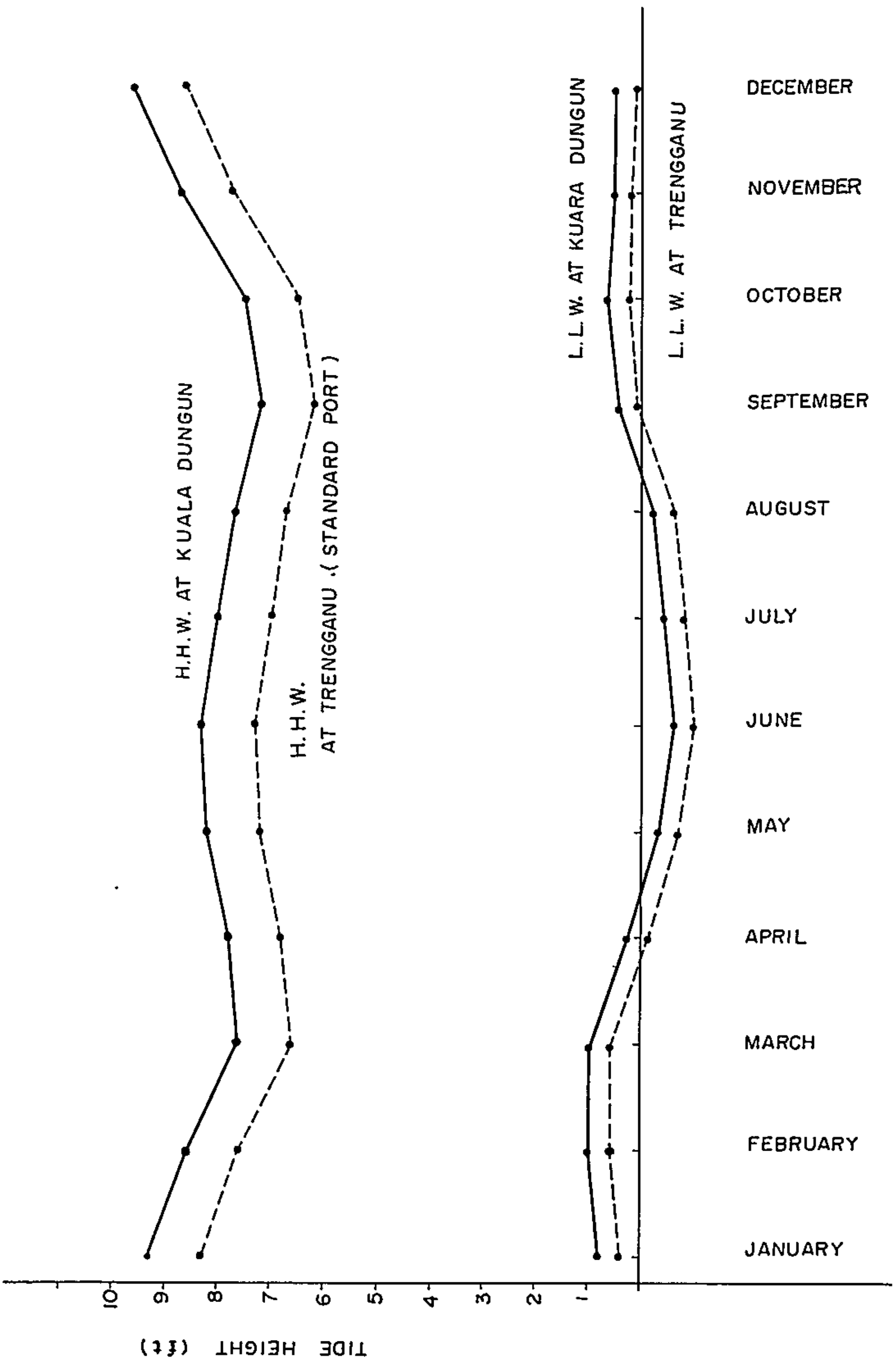
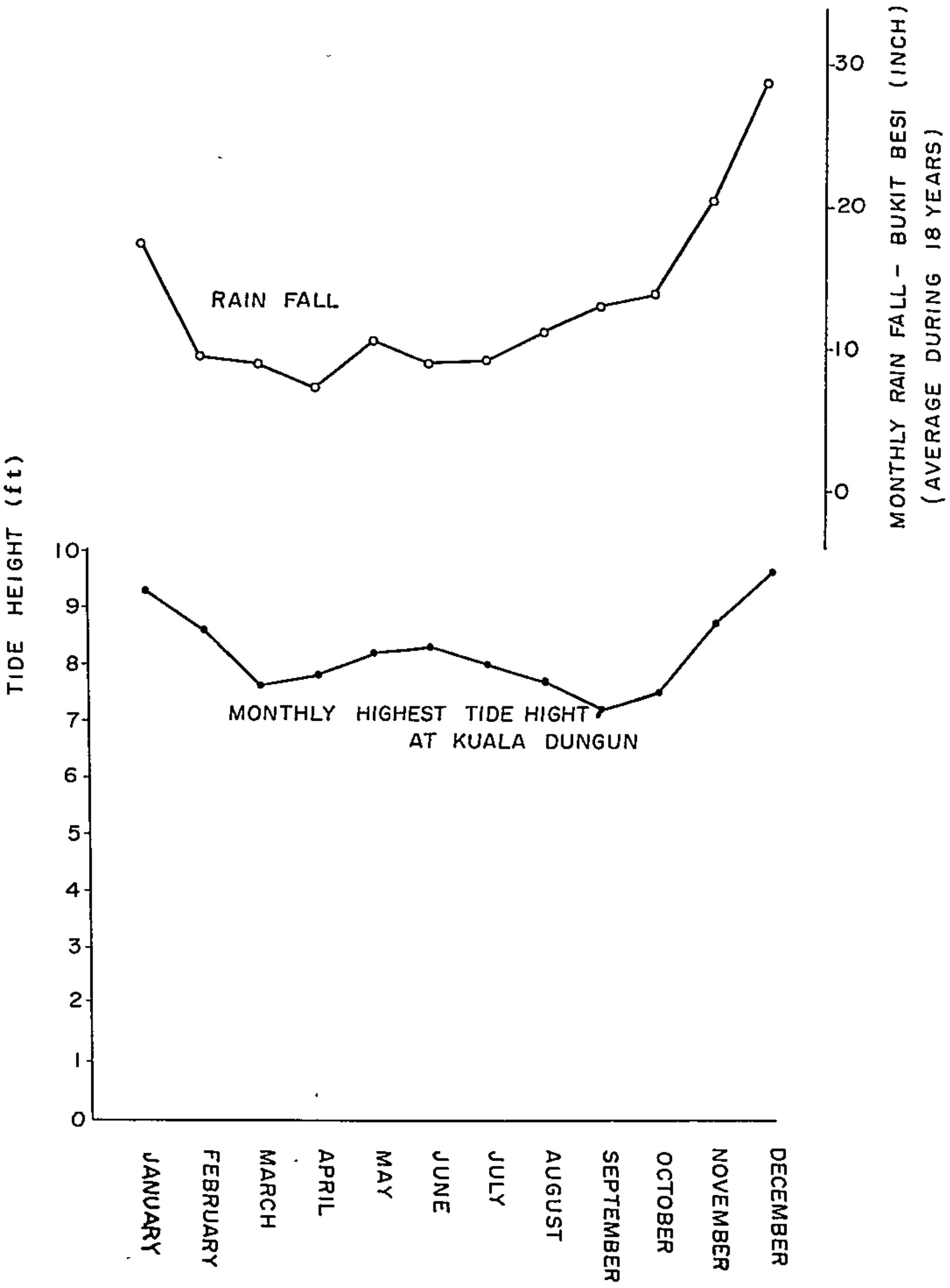


FIG.- 3.4 MOTHTY RAIN FALL AND H. H. W. AT KUALA DUNGUN



Thus we obtained the relationship between the maximum tidal level and the water quality of the Dungun during our investigation. Furthermore, in order to get the annual relationship between them, we estimated the monthly maximum and minimum tidal level for 1967 at Kuala Dungun, using the tide table *[1)] offered by Malaysian authorities. The results are shown in Figure 3-3.

Next, we wanted to study the rain fall in this area. First, we had to obtain the rainfall records of the Dungun Basin, and we used the records which had been investigated for the last 18 years at Bukit Besi Mine by Eastern Mining & Metals Co., Ltd (E.M.M.C.O). They are shown in Table 3-6.

To examine the reliability of these records, a comparison was made with earlier ones *[2)] (Rainfall Record, 1879 - 1958), the result of which is shown in Table 3-7. Station No. 32 in the table is in Kg. Jerangu Malay School about 60 miles north of Bukit Besi, and Station No. 42 in Bukit Besi Malay School. Table 3-7 indicates that the records of E.M.M.C.O. are sufficiently reliable. Therefore, Table 3-6 containing an 18 years' record shows the following ;

1) February to October is the dry season.
   November to January is the rainy season.
2) The month having the least amount of rainfall is April followed by March.
3) The month having the highest amount of rainfall is December followed by November and January.

Table 3-7 Comparison of Monthly Rainfall

		Bukit Besi (EMMCO)	No. 32 Kg. Jerangu Malay school	No. 42 Bukit Besi Malay school
1957	January	10.41	--	--
	February	5.77	--	8.86
	March	8.62	8.90	9.64
	April	4.83	4.31	5.46
	May	9.67	3.77	10.17

	June	11.39	19.87	12.24
	July	7.31	4.76	7.72
	August	8.39	8.39	10.98
	September	18.27	18.83	17.41
	October	15.24	19.71	15.80
	November	24.73	30.64	25.30
	December	43.23	51.75	42.82
1958	January	10.08	8.09	10.45
	February	8.64	5.41	8.31
	March	3.00	5.86	2.69
	April	0.54	0.46	1.29
	May	5.17	6.88	9.63
	June	8.03	8.07	8.58
	July	5.12	3.25	4.95
	August	11.76	13.08	13.23
	September	9.64	--	10.33
	October	18.26	19.30	18.94
	November	34.31	30.30	32.99
	December	7.45	8.93	7.82

The relationship between the monthly mean rain fall ' and ' the monthly highest tidal level ' is presented in Figure 3-4. As seen in this figure, the closer the two curves approach, the more sea water contamination of the Dungun River occurs. It is not reasonable to compare the rainfall curve with the highest tidal level curve directly, since run off is slightly below rainfall. However, we estimated that the strongest influence of sea water takes place in April when the rainfall is the least. What we wanted to know was, first, the maximum tidal reach of a year, and secondly the daily maximum time interval when the chloride ion concentration exceeds 200 ppm at point No. 4. These accurate values depend upon the actual investigation of the year. However, we concluded as follows through the data investigated in September such as the highest tidal level, the rainfall and the chloride ion concentration ;

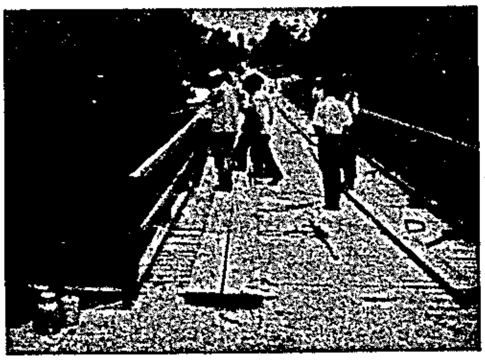
(1) The strongest influence of sea water will take place in April ; (2) The maximum tidal reach of this period will be at point No. 5 ; (3) The chloride ion at point No. 4 will exceed 200 ppm for 3 hours in that time.

*1) The tide table for Malaysia Including Supplementary Tables and Information for the year 1967.
*2) Drainage and Irrigation Department, Federation of Malaya ; Hydrological Data, Rainfall Records, 1879 - 1958.

(b) The Highest Water Level and the Lowest Water Level.

The intake point must satisfy two conditions ; first, it must be in enough quantity and qualities for the raw water, secondly, the intake facilities must be easily constructed. In order to examine if the point under consideration satisfies the two conditions and to obtain the design factors of the intake facilities, we had to discover the highest and the lowest water levels of the point. We studied the highest and the lowest water levels at No. 4. As for the highest, the dwellers near the point told us that the level experienced had been that of the flood in January 1967, which was shown in the photograph. It was surveyed by levelling to be 15' - 11" *.
One more foot was added for safety, and the construction maximum level came to 16' - 11".

No. 1 Intake Point



The lowest level, was estimated to be 0' - 5" one foot lower than 1' - 5" which was surveyed at 19:00, September 13th 1967 when the monthly lowest tidal level of September occurred. We hope that the lowest will be re-established at the designing of the actual construction.

From the investigation results obtained above, we concluded that point No. 4 satisfies the necessary conditions for the construction of intake facilities.

* All the ground heights and the water levels in this report were leveled on the basis of P. W. D Bench-marks.

(c) Determination of the Intake Point

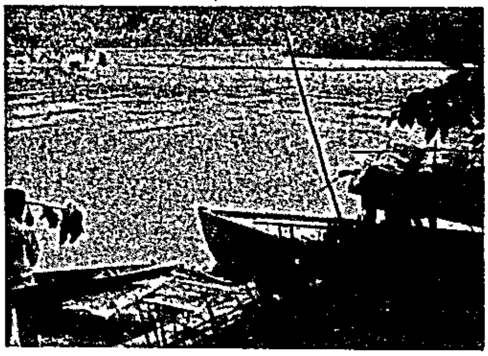
From the survey results obtained above and our consideration of them, we concluded that No. 4, Kg. Seperah, would be the most reasonable and economical intake point for the municipal water supply of Dungun. The reasons of which are summarized as follows ;

1) Point 5 is thought to be outside of the tidal influences througnout the year, but it is too far from Dungun to be economical.

2) No. 4 is about 3 miles nearer than No. 5 to Dungun, so the construction of the conveyance pipe line from No. 4 to Dungun will cost less than that from No. 5 by three miles' expenses.

3) At No. 4 the chloride ion exceeds the basic standard during 1-3 hours a few days every month, when the collection of water must be stopped. The time interval of the excess depends upon the relationship between the tidal level and the river quantity.
Therefore, the lower the tidal level and the more the river quantity, the shorter the interval becomes. The disadvantages of the three hours' stoppage at most are as follows : first, the hourly capacities of the purification facilities becomes larger to supplement, secondly, the construction cost becomes larger to some extent. But the advantage stated in item 2) is enough to cover the disadvantages. Furthermore, the stoppage of the intake pump could easily be operated automatically by the automatic chlorine gauge.

No. 4 Intake Point



Chapter 4. Water Supply Plant

4-1 Outline

In preparing the water supply plant plan, we tried principally to devise a plan that would satisfy those conditions mentioned in the preceding chapters, and one that would be easy to operate, maintain and manage, and low in cost. The standard was set by the standards of water facilities in Japan.

We have employed in the Report and accompanying charts and tables the foot-pound system so as to make it readily understood in Malaysia. The metric system was used for the actual preparation, in the report the foot and pound system was substituted. The small difference produced by the conversion can be ignored.

With regard to the outline of the plant, the original water taken from the Dungun River at Kg. Seperah is sent under pressure to the flash mixer to be mixed with chemicals then, passes through the measuring weir, and is led to the flocculator. The water, separated from flocs in the Sedimentation tank, is dropped to the gravity filter to be purified completely by filtration. The filtration water is sterilized with chlorine, and stored in the reservoir Bt. Chatok and then distributed to each area. The water is also used for extinguishing fire. This plant can be inspected by the inspecting board, and the necessary process is operated simply by electricity or air pressure. The number of workmen required for the maintenance operation per day will be 9. And they will work on a three-shift system.

The characteristics of this plant are to stop the intake of water during high tide when chloride ion in the water goes beyond 200 ppm; and secondly,to be able to provide water for drinking regardless of whether or not the pump for stopping the intake is in operation.

The intake tower (excluding the pump), rising mains, flash mixer, filter, supply mains and distribution mains of this plant are all adjusted to the requrements of the 1980 plan.

The construction of the water treatment plant requires at least 1.2 acres of land (190ft. x 280ft.). If in addition, they want to build employee housing and recreation facilities an additional acreage is required.

4-2 Intake and Rising Mains

As a countermeasure for the period of high tide, the possibility of constructing a reservoir at the intake site was considered to store the original water from high tide, and thus operating the pump continuously. But, since there was no place appropriate to build a reservoir near the actual place of intake, reservoir construction cost was expected to be high, and operation is rather complicated as well as uneconomical. Therefore this idea was not employed.

The intake pump is operated to stop or to start by the warning signals of the salimometer installed at the place of intake, which controls the operation switch board of the Treatment Plant.

According to an investigation, the maximum flood level and the lowest water level differ greatly. As a counter-measure for this, a submergible pump will be used and installed in the intake tower.

The rising mains will be placed along available roads, which are even and connect the intake place with the treatment plant. The pipes will generally be made of asbestos coment, and the pipes for river crossing will be steel. Air relief valves and drain valves will be installed according to necessity. The total head for the intake pump is about 131 feet. Therefore it is not necessary to install a surge tank.

4-2-1 Planned Intake Amount

The expected amount of the water supply in 1980 is 591,600 gallons per day; and 863,600 gallons per day in 1995. 5.2% of additional water supply is estimated for operation and maintenance of the plants, swelling the plant intake amount to 622,400 gal/day in 1980 and 908,500 gal/day in about 1995.

4-2-2 Intake Tower ; 1

Structure ; reinforced concrete
Size ; 25'-0" (L) x 15'-0" (W) x 50'-0" (H)

Screen ; 2
Structure ; shape steel and hoop
Size ; 24" x 24"
Mesh Size ; 25.4 (ASTM)

Fittings of Screen ; 2
Sluice Gate ; 2
Type ; rectangular
Size ; 24" x 24"
Material ; Body - FC
Sheet - BC

Head stock; 2
Type ; external screw type driven by gear.
Material ; FC

Rod ; 2
Material ; SUS - 50

Fixing metals of rod ; 2

Level meter ; 1
Type ; driven by float with alarm contact point at the upper and lower limits.

4-2-3 Intake Pump ; 2 (including one spare)
Type ; submergible pump
Capacity ; 506 gal/min.

Diameter ; 6"

Total Head ; 131 feet

Revolution ; 2,900 r.p.m.

Motor ; 440V, 50 c/s, 30 kw.

Starting ; star - delta

1. Pump accessories

Submergible Cable (three phases, four lines) ; 2

Pump Bed 18" x 18" ; 2

Air Valve ; 2

Cable Clip ; 2

2. Rising Pipe ; 2

Diameter ; 6"

3. Delivery Valve ; 2

Type ; Sluice Valve.

Diameter ; 6"

Material ; FC

4. Check Valve ; 2

Type ; swing type

Diameter ; 6"

Material ; FC

4-2-4 Bridge ; 1

Structure ; truss, steel made.

Span ; 60 feet

Width ; 4 feet

4-2-5 Rising main

Total Length ; 8,590 feet (10" Dia.)

Materials ; Asbestos Cement.

Designed flow velocity ; 3.6 feet/sec (in 1995)

Accessories

Desludge Valve ; 3
Type ; Sluice valve.
Diameter ; 3"
Material ; FC

Desludge valve box ; 3
Type ; Screw-type.
Material ; FC

Air Valve ; 3
Type ; single
Diameter ; 1"
Material ; FC

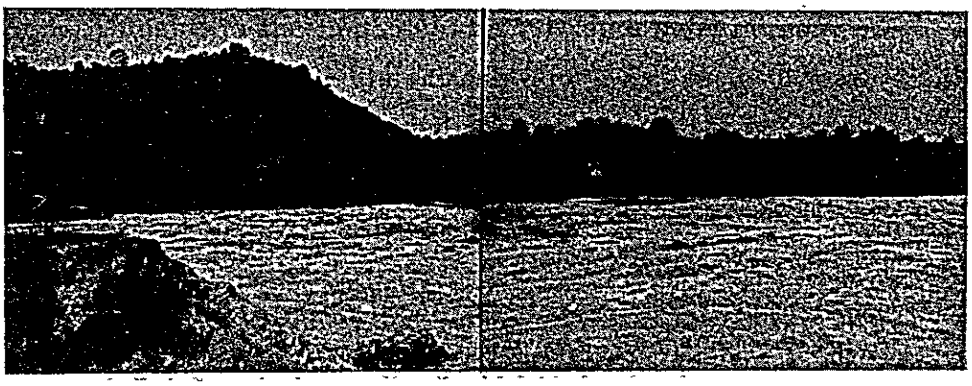
Air valve chamber ; 3
Structure ; reinforced concrete, with a cover of cast iron.
Size ; 1'-9-1/2" (L) x 1'-1-1/2"(W) x 2'-8" (H)

Rail crossing ; 1
River crossing ; 1

4-3 Treatment Plant

The treatment plant consists of a flash mixer, chemical dosing equipment, flocculator, horizontal sedimentation basin, rapid sand filter, sterilizing equipment, PH controller, filter and necessary affiliated buidings; and will be constructed at the foot of Bt. Chatak where a distribution basin will be built. It is advisable to build the Treatment Plant near the intake point. But, since the ground level at the place of intake is very low, and there is a threat of flooding during the season, we have chosen the place as mentioned, where the ground level is high. This site is convenient for the disposal of sludge and wash water from the filter.

The Site of Water Treatment Plant



Some characteristics of the above plant are a horizontal sedimentation basin and a surface washing apparatus of the filter. Though the recent general tendency is to install high rate sedimentation basins, in our case we have decided on the horizontal sedimentation basins which are more stable to operate, considering that the apparatus has to be stopped temporally during high tide.

In washing the filter, the most prevalent method in Malaysia is the air scour system. However we decided to employ the surface washing system which is prevalent in U.S.A. and Japan because it is superior to the air scour system. The prodecure of the surface washing system is as follows: Preceding a back wash, high pressured water is spurted out to the surface of the filter layer from many nozzles placed above the filter layer to break the mud layer, and wash it away effectively by causing sand grains to collide inducing friction which also prevents the formation of mudballs. In Japan, the air scour system was used, but recently it has been replaced by the surface washing system.

Our commission investigated the conditions of washing filter basins in Malaysia. In those cases in which the air-scour system was employed a mud layer was not broken and remained even after washing due to the inefficiency of the wash, and the surface of the filtering layer was cracked, the method impeded the efficiency of the filter.

The water necessary for the chemical dosing equipment, sterilizing apparatus, PH controller and for other miscellaneous business in the plant is taken from the supply main.

4-3-1 The Expected Amount Of Water Treatment

The amount of the water treatment equals the planned water intake:

In 1980 .... 622,400 gallons per day

In 1995 .... 908,500 gallons per day

4-3-2 Flash Mixer

The flash mixer holds simultaneously the flow-controlling function, and at its outlet the flow of water is able to be measured.
The process is as follows ; first, the lime milk is distributed through the raw water jetting in, the flash mixer secondly, they are mixed sufficiently by the rapid mixer, and lastly, the alum is poured just before the measuring weir.

Structure ; reinforced concrete.

Inside ; Water-proofed mortor finish.

Size ; 19'-0" (L) x 6'-0" (W) x 5'-9" (H)

Capacity ; 3,000 gal

Retention time ; 4.5 minutes (in 1995)

1 Mixer ; 1

Motor ; 1

Type ; Three phase induction motor, totally enclosed, fan cooled. 440V, 50 c/s, 2.2 kw

Rating ; continuous

Reduction Gear ; 1

Type ; Double geared drive

Reduction Ratio ; 1:15

Impeller Blade ; 2

Type ; Three blades.

Outside Diameter ; 20"

Revolution ; 100 r.p.m.

Peripheral Velocity ; 8.7 feet/sec.

Material ; SUS-27

Propeller shaft ; 1

Material ; SUS-27.

2. Pipes and Valves ; 1 set.

Inlet Pipe ;

Diameter ; 10" CIP

Inlet Valve ; 1

Type ; Sluice Valve

Diameter ; 10"

Material ; FC

Outlet Pipe ;

Diameter ; 10" CIP

Desludge Pipe ;

Diameter ; 4" CIP

Desludge Valve ; 1

Type ; Sluice Valve

Diameter ; 4"

Material ; FC

Over-flow Pipe

Diameter ; 8" CIP

Inlet Valve Chamver ; 1

Structure ; reinforced concrete..

3. Measuring Weir ; 1

Type ; rectangular weir

Material ; SUS-27

Rectification wall ;

Type ; multi-holes

Structure ; reinforced concrete, polyvinyl chloride pipe buried.

4. Ladder and Hand Railings ; 1 set

Structure ; shape-steel and steel pipe

4-3-3 Chemical dosing equipment

This apparatus consists of the injectors of alum and calcium hydroxide. Alum is used in a dry state. It is dissolved in the solution tank and then injected by gravity after measurement.

The fixed quantity of calcium hydroxide is transmitted to the emulsifier after it is injected by the dry fixed quantity type, and then poured in by gravity.

From the results obtained at the water-quality analysis, it was proved that the normal quantities were about 20ppm of Alum and about 10 ppm of calcium hydroxide.

1. Alum dosing Apparatus

Solution Tank ; 2 (including one spare)

Structure ; steel plates with internal rubber lining

Size ; 4'-0"(L) x 4' - 0" (W) x 3'-4" (H)

Capacity ; 240 gal.

Agitator ; 2 (including one spare)

Type ; Vertical gear drive.

Revolution ; 290 r.p.m.

Material ; SUS -32 under the water level

Motor ; 440V, 50 c/s, 0.75 k

Constant Head Tank ; 1

Material ; SUS-32

Dilution Pipe

2" SGP

1" SGP

Dilution Valve

Stop valve (BC) 2" ; 1

Stop valve (BC) 1" ; 2

Solution dosing Pipe

1" PVC

Solution Valve ; 2

Type ; stop valve

Diameter ; 1"

Material ; SUS-27

Blow Pipe

1" PVC

Blow Valve ; 2

Type ; ball-tap valve

Diameter ; 1"

Material ; SUS-27

Float Valve ; 1

1" PVC

Tank stand ; 1

Structure ; shape steel and steel plate.

2. Lime dosing apparatus

Dry feeder ; 1

Capacity ; 0.053 ft^3/hr - 0.353 ft^3/hr.

Motor ; 440V, 50 c/s. 0.2 kw

Lime Milk Tank ; 1

Structure ; steel plate

Size ; 3'-4"(L) x 3'-4" (w) x 2'-6" (H)

Capacity ; 80 gal

Dilution Pipe

1" SGP

Dilution Valve ; 1

Type ; stop valve

Diameter ; 1"

Material ; BC

Lime Milk dosing Pipe

Material ; rubber hose.

Diameter ; 1"

Outlet Valve ; 1

Type ; ball-tap valve

Diameter ; 1"

Material ; FC

Blow Pipe

1" PVC

Blow Valve ; 1

Type ; ball-tap valve

Diameter ; 1"

Material ; FC

Stand for tank and Hopper ; 1

Structure ; shape steel and steel plate

3. Chemicals Transportation Apparatus

Hoist ; 1

type ; Mini-hoist with electric trolley.

Capacity ; 550 lb x 20 feet

Motor Power ; 0.05 kw for running

0.5 kw for lifting

4-3-4 Flocculator

We designed two flocculator. Each of their retention time was calculated under the consideration of the designed water-supply quantity. It came to 45 minutes when the two basins were operated, and to half the time, 22.5 minutes, when only single in such cases as the basin-clearance and etc. The retention time is usually designed to be about half an hour. The type of the slow mixer was planned to be the mechanical horizontal double-gear flocculator. The bottom of the basin was planned to be curved so that the floc might not precipitate.

Structure ; reinforced concrete

Inside ; water-proof mortar finish.

Size ; 21'-0"(L) x 17'-6"(W)x11'-0"(H)

Capacity ; 19,800 gal/basin

Retention Time ; 70 minutes

Motor ; 2

Type ; Three phases induction motor, totally enclosed, fan cooled.
440V. 50 c/s, 1.5 kw

Rating ; continuous.

Variable Speed Gear ; 2
    Variable Range ; 0.2 - 0.8

Speed Reducer ; 2
    Reduction Ratio ; 1: 187

Paddle ; 4
    Type ; Horizontal.
    Outside Diameter ; 9 feet
    Revolution ; First stage, 2.4-6.4 r.p.m.
        Second stage, 1.87 - 5.0 r.p.m.
    Peripheral velocity; First stage, 2.4-6.4 r.p.m.
        Second stage 0.585-2.34 feet/sec.
    Material ; wood

Submergible Bearing ; 8
    Material ; body - FC
        main part - Lignumvitae.

Water sealing device ; 4
    Type ; Gland sealing

Flexible Coupling ; 4
    Type ; flange
    Material ; body - FC, main part-hard rubber

Common Bed ; 2

Vee belt and pulley ; 2

Sprocket wheel ; 8

Chain ; 4

Inlet Pipe ; 8" CIP

Inlet Valve ; 2
    Type ; Sluice valve.

Diameter ; 10"

Material ; FC

4-3-5 Sedimentation Basin

We designed two sedimentation basins. Each retention time was calculated under the consideration of the disigned water-supply quantity. It came to 4 hours and a half when the two basins were simultaneously operated, and to half the time, 2 hours and a quarter, when only a single was done in such cases as the basin-clearance and soon. The retention time usually designed is about 3 hours.

To make the sedimentation effective, the rectification walls were to be constructed, and for the same purpose the outlet water collection was designed not by the over-flow system but by the submergible pipe system so that the rapid ascending current near the outlet could be prevented.

The clearance process of the basin is as follows ; first, the valve in the middle wall is closed, then the water disappears, and lastly, the basin is cleared by the valve operation and the washing hose.

Structure ; Reinforced concrete.

Inside ; water proof & mortar finish

Size ; 65'-0"(L) x 17'-6"(W) x 11"-6"(H)

Capacity ; 67,500 gal/basin

Retention time ; 217 minutes

Rectification wall ; 3

Type ; multi holes

Structure ; re-inforced concrete, polyvinyl chloride pipe buried.

Outlet Pipe

6", 8", 12". CIP

Outlet Valve ; 4

Type ; sluice valve

Diameter ; 6"

Material ; FC

Desludge Pipe:

6" CIP

Desludge Valve ; 2

Type ; Sluice valve

Diameter ; 6"

Material ; FC

Connection pipe ; 6" C.I.P.

Connection valve ; 2

Type ; sluice valce

Diameter ; 6"

Material ; FC

Head stock ; 2

Type ; external screw type, hand operate

Material ; body - FC

Desludge Valve Box ; 2

Type ; screw type

Material ; FC

4-3-6 Filter.

We designed three rapid filter, one of which is the spare. The filtered water is collected by the perforated pipe of vinyl chloride. For the back-washing water, the filter is used, which is taken just before the measuring apparatus in the main pipe after reducing the pressure to 21 Lb/square inch. The outlet flow quantity is controlled by the air-type flow adjustment apparatus. Washing the basin is started by the alarm of the head-loss meter handled on the platform.

Structure ; reinforced concrete

Inside ; water proof & mortar finish.

Size (each) ; 16'-0"(L) x 12'-0"(W) x 11'-0"(H)

Filter Area ; 165 ft^2/basin

Rate of filtration ; 100 gal/ft^2/hr.

Rate of Back-washing ; 650 gal/ft^2/hr

Rate of Surface-washing ; 260 gal/ft^2/hr.

Expansion Ratio of Sand ; 30%

Washing Process ;

Surface Washing ; 3 minutes

Back-washing ; 6 minutes

Settling ; 5 minutes

Rinsing ; 3 minutes

1. Surface Washing System

   Type ; fixed

   Material ; nozzle - BC

   pipe - steel

2. Under Drain system

   Type ; perforated

   2" PVC

3. Pipes and valves in the Piping Gallery

   Pipe ; cast-iron

   Valve ; pneumatic

Inlet Pipe ; 6" CIP

Inlet Valve ; 3

Type ; sluice valve

Diameter ; 6"

Material ; FC

Outlet Pipe

10", 6", CIP

Outlet Valve ; 3

Type ; sluice valve

Diameter ; 6"

Material ; FC

Wash Water Inlet Pipe ; 10", CIP

Wash Water Inlet Valve ; 3

Type ; sluice valve

Diameter ; 10"

Material ; FC

Surface-wash Inlet Pipe.

8" , CIP

Surface-wash Inlet Valve ; 3

Type ; sluice valve

Diameter ; 8"

Material ; FC

Drain Pipe ; 12" , CIP

Drain Valve ; 3

Type ; flat

Diameter ; 12"

Material ; FC

Rinsing Pipe ; 5", CIP

Rinsing Valve ; 3

Type ; sluice valve

Diameter ; 5"

Material ; FC

By-pass Pipe ; 5" , CIP

By-pass Valve ; 3

Type ; sluice valve

(driven by hands)

Diameter ; 6"

Material ; FC

4. Trough ; 6

Structure ; steel, coated with unticorrosive paint

Size ; 16'-0"(L)x1'-0"(W)x10"(H)

Slope ; 2/100

5. Filter Media

Filter Sand ; 330 ft^3/basin x 3

Size ; 0.018 - 0.028 inch

Uniformity Coefficient ; under 1.7

Depth ; 2'-0"

Filter Gravel ; 260 ft^3/basin x 3

Size ; 0.08 - 1 inch

Depth ; 1'-8"

6. Wash-water Piping

In the purification plant, the cast-iron pipe of 10" in diameter was designed, and from the plant to the distribution reservoir, an asbestos-cement pipe. And a field type flow indicator was to be attached.

Reducing Valve ; 1

Diameter ; 10"

Material ; FC

Reducing Valve chamber ; 1

Structure ; reinforced concrete

Size ; 4'-0" (L)x4'-0"(W)x5'-0"(H)

Flow Indicator ; 1

Type ; Venturi (10" dia)

Venturi chamber ; 1

Structure ; rein-forced concrete

Size ; 8'-0"(L) x 5'-0"(W) x 5'-8" (H)

4-3-7 Sterilization Apparatus

For the sterifization of water, a vacuum type chloride injector for waterworks purposes was designed, which would inject the chlorine water to the entrance of the pure water basin.

The quantity of chloride should be calculated so that the free residual chloride would not usually be under 0.1 ppm at the end of the service pipes.

1. Chlorinator ; 2 (including one spare)

   Type ; vacuum

   Capacity ; 2.2 lb/hr at maximum

2. Chlorine-bombe ; 2

   Capacity ; 110 lb.

3. Accessories

   Four-valves Manifold ; 2

   Auxiliary Valve ; 11

   Pressure-gauge with Alarm Contact ; 1

Platform :weighing machine ; 1

Copper-pipe

Poly vinyl chloride pipe

Pipe and Valves

4-3-8 pH control Apparatus.

To adjust the pH value of the feed-water between 7 and 8.5, the pH adjustment apparatus was designed. The liquid lime of the fixed quantity would be injected to the entrance of the pure water basin, after the hydrated lime was emulsified. Furthermore, this apparatus would also serve as the spare chemicals feeder.

1. Dry feeder ; 1

Type ; automatic injector of the fixed quantity.

Capacity ; 0.053 ft^3/hr - o.353 ft^3/hr.

Motor : 440V, 50c/s, 0.2 kw

2. Lime milk Tank ; 1

Structure ; hoop

Size ; 3'-4"(L) x 3'-4"(W) x 2'-6"(H)

Capacity ; 80 gal

3. Attached Pipe and Valve.

Dilution Pipe ; 1", SGP

Dilution Valve ; 1

Type ; stop valve, BC

Diameter ; 1"

Lime milk dosing Pipe ;

Rubber hose (1")

Outlet Valve ; 1

Type ; ball - tap valve, FC

Diameter ; 1"

Blow Pipe ; 1", PVC

Blow Valve ; 1

Type ; ball-tap valve , FC

Tank and Hopper Stand

Structure .; shape steel and steel plate.

4-3-9 Filtered Water Tank ; 1

The filtered water tank was designed so that it would have the needed service capacity in 1995.

Structure ; reinforced concrete, water-proof mortor finish.

Size : 30'-0"(L) x 25"-0"(W) x 12'-6"(H)

Capacity ; 38, 500 gal

Desludge Pipe ; 6", CIP.

Desludge Valve, ; 1

Type ; sluice valve.

Diameter ; 6"

Material : FC

Desludge Valve Case ; 1

Type ; screw type

Material ; FC

4-3-10 Accessory Buildings

For purpose of the operation, the maintenance and management of the water treatment plant, the main building was designed to have rooms for operations, electricity, pumping, piping, chemicals injection, chemicals storage, the sterilization, the water-quality analysis, the business and showers - baths.

Finishing of the Room

Room	Panel	Wall	Celling	Floor
Control room	Vinyl paint	Plaster	Plaster	Linoleum
Electrical room	Plaster	Plaster	Bare	Linoleum
Pump room	Vinyl paint	Plaster	"	Terra 330 tile
Piping gallery	Bare	Bare	"	Bare
Chemical room	Acid-proof mortar	Acid-proof mortar	Acid-proof mortar	Acid-proof mortar

Chemical store	Bare	Bare	Bare	Bare
Chlorine room	acid-proof mortar	acid-proof mortar	acid-proof mortar	acid-proof mortar
Laboratory	Mosaic	Plaster	Acoustic board	Moasaic-tile
Office	Plaster	Plaster	Acoustic board	linoleum
Lavatory	Mosaic tile	Plaster	Bare	Mosaic
Night duty room	Plaster	Plaster	Acoustic board	Linoleum
Kettle room	Mosaic tile	Mosaic tile	Mosaic plaster	Mosaic tile
Passage	Plaster	Plaster	Acoustic board.	Clinker tile

4-3-11 Apparatus and Equipment for Water-quality Analysis

As a rule, the reagents were decided not to be adjusted in the plant ; therefore, the apparatus and the equipment needed in this plant are those of the water-quality analysis. The items of the water-quality analysis are as follows ;

Turbidity

pH

Conductivity

Color

Water temperature

Alkalinity

Chloride ion

Residual chlorine

Coagulation test

Therefore, the apparatus including reagent and the equipment needed for the water quality analysis are as follows ;

Testing Table

Size ; 25ft x 40 ft

Sink ; 1

Size ; 20 ft x 25 ft

Material ; SUS - 27

Rack for Reagent

Size ; 80 ft x 10 ft x 27 ft

Jar Tester (sextuple) ; 1

Thermometer (0°-50°C) ; 2

Apparatus for measuring turbidity ; 1

Apparatus for measuring color ; 1

pH meter ; 1

Conductivity Meter ; 1

Testing Apparatus for Chloride ion, and Alkalinity ; 1

Apparatus for measuring residual chlorine ; 1

4-3-12 Miscellaneous Construction Works

Catch Basin

Structure ; reinforced concrete

Drain-pipe

Type ; Hume concrete pipe

Gutter Structure ; U-shaped concrete.

Gate, Fence and Road.

4-4 Filtrate pump and supply main.

This facilities consist of filtrate pumps and supply pipes. The planned water delivery is set, for the pump, at 622, 400 gal/day, which is to fulfill the delivery required in 1980, and, for the pipe, at 908, 500 gal/day, which is to fulfill the delivery required in 1995.

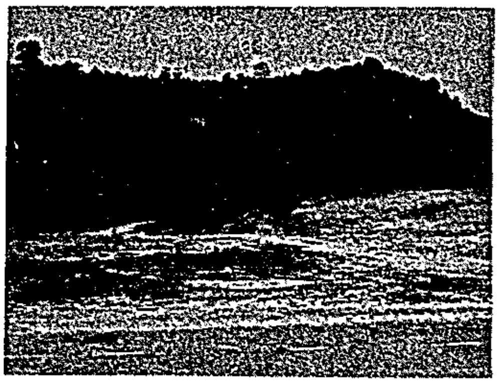
4-4-1 Filtrate pump ;	2 (one of which is a spare,)
Type ;	horizontal multi-stage turbine.
Capacity ;	506 gal/min
Total head ;	160 ft.
Motor ;	2
Type ;	3 phase induction motor, Totally-closed-fan cooled, with space heater. 440V, 50 c/s, 37 kw.
Revolution ;	1, 500 r.p.m.
Accesories ;	
Suction pipe ;	6" CIP
Foot valve ;	6" 2
	Material ; FC
Delivery pipe ;	10" CIP
Delivery valve ;	10" 2
	Type ; Sluice valve
	Material ; FC
Check valve	10" 2
	Type ; Swing
	Material ; FC

4-4-2. Supply main ;	
Total length ;	1900 ft. (10" Dia)
De-sludge valve ;	3" 1.
	Type ; Sluice valve.
	Material : FC
De-sludge valve chamber ;	
	Type ; Screw
	Material ; FC

4-5 Reservoir and Distribution Pipelines

The distribution facilities consist of a reservoir and distribution pipes. The reservoir is to be a square structure of reinforced concrete, and will be constructed on Bt. Chatok at 140ft. above sea-level. Its capacity will be 30.3 M.G., which is a half-day capacity on the basis of the planned water delivery for 1980.

The Hill Proposed to Reservoir Site



For the most part, the distribution pipes will be made of asbestos cement was computed by the H.C. (Hardy Cross) method by using a computer, so as to make the pressure at the end of the distribution pipe 21 lbs/in^2 ($1.5kg/cm^2$) based on the planned maximum per-hour delivery which will be required in 1995.

For areas to be served as in 1980, areas with a high density of population have been chosen, taking economic efficiency into consideration.

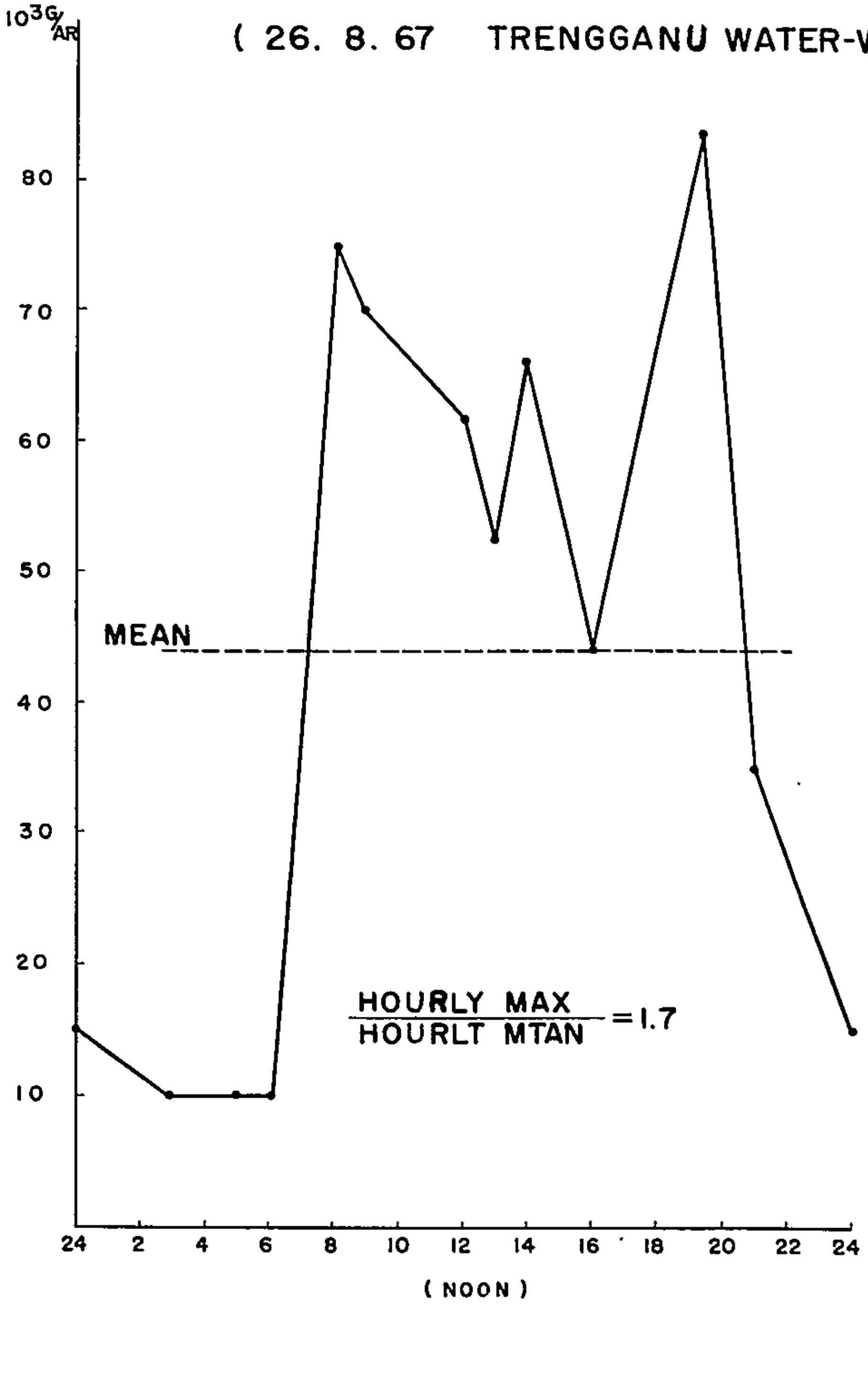
Where the pipe is laid along a bridge or across a railway, steel pipes are to be used. An air valve and a desludge valve are to be provided where necessary. For every mile pipe, 4 fire hydrants are to be provided.

4-5-1. Water Distribution Plan.

Planned Year	Population Served	gallons per head per day consumption	Planned consumption (gal/day)	Maximum capacity of pipeline (gal/day)
1980	20,400	29	591,600	1,005,700
1995	25,400	34	863,600	1,468,100

FIG. 4-1 HOURLY WATER CONSUMPTION

(26. 8. 67 TRENGGANU WATER-WORK)



The planned per-hour maximum delivery was computed by multiplying the per-day average water delivery by 1.7, the ratio of the daily average water delivery of Trengganu water service to the daily maximum water delivery as shown in Fig. 4-1.

4-5-2. Reservoir

Structure : Reinforced concrete, water-proof mortar finish.

Size ; 61'-0"(L) x 55'-0"(W) x 20'-2"(H)

Capacity ; 0.3M.G.

1. Auxiliary piping and valves.

Inlet pipe:	10" CIP	
Inlet valve:	10"	2
Type:	Sluice valve	
Material:	F.C.	
Outlet pipe:	14" CIP	
Outlet valve:	14"	2
Type:	Sluice valve	
Material:	F.C.	
Outlet pipe:	14" CIP	
Outlet valve:	14"	2
Type:	Sluice valve	
Material:	F.C.	
Blow off pipe:	6" CIP	
Blow off valve:	6"	2
Type:	Sluice valve	
Material:	F.C.	
Overflow pipe:	12" CIP	
Conjunction pipe:	6" CIP	
Conjunction valve:	6"	
Type:	Sluice valve	
Material:	F.C.	
Valve stand		1
Material:	F.C.	

2. Measuring instruments

Flow totalizing recorder 1

Type: Mechanical driven

Venturi Tube 14" Dia

Underground venturi chamber

Structure: Reinforced concrete

Size: 10'-0" (L) x 7'-6" (W) x 12'-0" (H)

Bypass pipe : 14" CIP

Bypass valve : 14"

Type : Sluice valve

Quality of Material : FC

4-5-3 Distribution pipe.

Name	Dia (inch)	Length(feet)	Remarks
Main	14	2,600	Asbestos cement pipe
"	10	4,900	"
"	8	6,800	"
"	6	10,700	"
"	5	30,200	"
"	4	11,000	"
Total		66,200	
Sub-main	2	3,600	Hard poly vinyl chloride
"	2	55,000	"
Total		58,600	
Grand Total		124,800	

Drain Valve

Type : Sluice valve .

3"	8
2"	1

Material ; FC

Drain Valve chamber ; 9

Type : Screw type

Material ; FC

Air relife valve ; 1" 7

Type : Single-jet air valve

Air relife valve chamber 7

Structure : Reinforced concrete
With cast-iron cover.

Size ; 1'-9 1/2"(L) x 1'-1 1/2"(W) x 2'-8"(H).

Rail way crossing at two places

Method ; Excavation.

River crossing at 6 places

Sluice valve

Type ; Sluice valve for use the of water service.

10"	1
8"	2
6"	2
5"	6
4"	3

Material ; FC

Sluice valve chamber 14

Quality of material : FC

4-5-4. Hydrant

Hydrants : 37

Type : Single, underground.

Diameter ; 3"

Hydrant chamber : 37

Structure : Reinforced concrete, with cast-iron cover.

Size ; 1'-9 1/2"(L) x 1'-1 1/2"(W) x 3'-8"(H)

4-6 Electrical Equipment and Instruments

Our commission and E.P.U. agreed that the electric power necessary for the water supply plant construction would be fully provided by the power plant of the N.E.B. district.

Accordingly it will be employed as our first choice, and an alternate suggestion will be described in 4-9

The maximum power demand of the plant is 108 KVA under the 1980 Plan, and 188 KVA under the 1995 Plan.

For the water supply plant, it is most desirable, from an economic stand point as well as that of efficiency to receive the power with 3000V, and regulate the voltage according to need. In order to accomplish this, the N.E.B. power station must install a booster to transform 440V to 3000 V for distribution.

Incoming power equipment will be installed in two places within the treatment plant site and at the place of intake. They will transform 3000V to the 440V necessary for motors, lighting, instruments and total power load.

4-6-1. Electrical Equipment.

Electrical equipment is to be installed in two places : the intake tower and the filter plant. The incoming panel and other equipment necessary for the intake tower are to be installed in a room in the upper part of the intake tower, and the pump is remote controlled by the control panel in the operations room of the filter plant, usually with no-one in the intake room to take care of the panel.

Each motor in the filter plant is operated by the control panel in the operations room. The motors for the chemical-dosing equipment, flash mixer, flocculator and filtrate pump are to be operated at their places of location.

The electrial equipment of the intake tower is composed of the following machinery and apparatus ;

1. High tension power incoming facilities.
2. Incoming panel. 1.

Location ; the pump room of the intake tower.

Attachments ; disconnecting switch,
oil circuit breaker.
protecting device from earthing, over current, and under voltage
voltmeter,
ammeter,
internal wirings.

3. Transformer panel 1

Location: same as in the case of incoming panel.

Attachments: high tension cut-out switch.
transformer (oil-immersed and self-cooled)
3,300/440V 75KVA, 3-phase, 4 line
240/100V 500VA, single phase,
disconnecting switch,
static condenser,
(with built-in discharge coil)
main isolating switch,
voltmeter,
ammeter,
box for metering outfit,

terminal box for meters,
internal wirings.

4. Motor panel — 1

Location: the same as the transformer panel.

Attachments:
circuit breaker,
starter,
operation switch,
signal light,
operation control circuit,
current transformer for the ammeter,
internal wirings.

5. Interior illumination equipment — 1

6. Cabling and wiring materials

The electrical equipment in water treatment is composed of the following machinery and apparatus:

1. High tension power incoming facilities,
2. Incoming panel — 1

Location: separate room at the site of water treatment plant.

Attachments:
disconnecting switch,
oil circuit breaker,
protecting device from earthing, over current and under voltage,
voltmeter,
ammeter,
internal wirings.

3. Transformer panel — 1

Location: in the same as the incoming panel.

Attachment:
high tension cut-out switch, transformer (oil, immersed, self-cooled)
3,300/440V 150KVA, 3-phase 4 wire,

	disconnecting switch,
	static condenser,
	(with built-in discharge coil),
	internal wirings.

4. Power distribution board

Location:	Electrical room.
Attachments:	main switch,
	circuit breaker,
	transformer 240/100V 1 ϕ 1KVA
	voltmeter,
	ammeter
	frequency meter
	internal wirings.

5. Main switch board 1

Location:	electrical room
Attachment:	main circuit breaker,
	branch circuit breaker,
	internal wirings.

6. Motor panel (for chemical room) 1

Location:	chemical room
Attachment :	circuit breaker,
	starters,
	operation switch,
	signal lights
	operation control circuit,
	internal wirings.

7. Motor panel (for pump room) 1

Location:	Pump room
Attachment:	starting rheostat,
	starter controller,
	pilot motor for starting rheostat,
	operation switch,
	signal light,
	operation control circuit,

internal wirings.

8. Operation stand for outdoor use 1
9. Lighting equipment

   Power distributing board for lighting 1

   Location: Electrical room.

   Attachments: circuit breakers, internal wirings.

   Indoor lightings:

   Type : Fluorescent lamp

   Outdoor lightings:

   Type: incandescent lamp with shade . (for filters) mercury lamps.
10. Cabling and wiring materials.

4-6-2 Instrumentation

The items to be detected by this equipment are as follows ;

(1) Salinity at the point of intake.

(2) The water level of the filtrate tank.

(3) The PH in the filtrate tank.

(4) The water level of the reservoir.

(5) The loss of head of each filter.

(6) The rate of flow in each filter outlet.

Of the above, instruments for Items (1) to (4) are to be provided on the instrument panel in the control room, and those for Items (5) and (6), on the filter control panel of each filter in the control room.

Instrumentation is composed of the following appliances ;

1. The instrument panel in the control room.

   .Location ; Control room

   Attachments ;

   ammeter for raw water pump,
   ammeter for filtrate pump,
   control switch for raw water pump,

control switch for air compressor,
motor operation indicating light,
alarm indicating light,
"Air failure"
"Brine intermixed"
"Filtrate tank water level high and low"
"Reservoir hight and low"
"Filter head loss increased"
"Filtrate tank PH high or low"
Push buttons for lamp testing and stopping busser"

Salinity (Brine) indicator.
Level indicator with alarm for filtrate tank.
PH indicator with alarm for filtrate.
Level indicator with alarm for reservoir.
Relay box for alarm.
Power unit for instruments
Internal wirings.

2. Filter control panel 3.

Location: Control room

Attachment ; four-way pilot valves
automatic valve operation indicator
loss of head indicators with alarm
rate of flow indicators for filter outets
internal wirings.

3. Air compressor for control 2.

Location ; Piping gallery.

Accessories ;
air receiver,
oil separator,
pressure reducing valve.

4. Instrument:

Salinity indicator with alarm for raw water 1.

To detect increases in salinity that may take place at a tide sensitive time and to give alarm when the valve set on the alarm meter is exceeded.

scale ; 0-300 ppm

type ; electromagnetic induction submergible cell and transmitter.

Level indicator with alarm for filtrate tank 1.

scale ; 0-15 ft.

type ; float-driven and electrical transmission with upper and lower limit alarm contact.

PH indicator with alarm for filtrate 1.

To detect and indicate the PH of filtrate, and to signal and alarm when it is abnormal.

scale ; 0-14 PH

type ; submergible glass electrode.

Level indicator with alarm for the reservoir 1.

Indication of and alarm to water level of reservoir

scale ; 0-20 ft.

type ; mechanical pressure convertor.

Loss of head indicator with alarm for each filter 3.

Indication of and alarm to the loss of head of the filter.

scale ; 0-10 ft

type ; differential-pressure conversion electrical transmission.

Rate of flow indicator 3.

To indicate flow at the outlet of the filter.

scale ; 0-15,000 gal/hr

type ; Venturi tube differential pressure conversion electrical transmission.

The flow rate is controlled automatically to keep the setting rate, which is fixed manually at site.

5. Wiring and piping materials for instrumentation.

4-7 Operation and Management

The plant is designed so that operation and management can be easily maintained. Since it greatly resembles the already existing water supply plants in Malaysia, workmen can be trained easily in any near-by plant. There are spares in reserve for the intake pump, chemical dosing equipment, sterilizing apparatus, and air compressor to secure full-time operation. The operation diary necessary for the maintenance of operation, and management must be kept daily.

4-7-1 Water Quality

In order to provide water that satisfies the W.H.O. standards, an inspection of chloride ion, turbidity, colour, PH values, residual chlorine and alkalinity, must be performed and recorded daily. Accordingly, these test apparatuses are necessary. The insepection of coliform groups and bacteria accounts should be performed at regular intervals by an adequate authority. The inspections show the condition and quality of the water; and if the water has any inadequacies for service, some measure must be taken. The dosing amount of coagulant and coagulant aid must be adjusted to the results of jar-tests. The amount of chlorine dosing should be determined after a chlorine-demand test.

4-7-2 Apparatuses

All the apparatuses operate on a full time basis with the exception of the filter, and an apparatus that stops temporally during high tide. The sludge of the sedimentation basin will be disposed of stopping the operation at regular intervals. The filter will be washed according to the following table:

	Time (min.)	Rate of filteration (gal/ft^2-Hr)	Amount of water (gal.)
Surface wash	3	260	2,140
back wash	7	650	12,500
Intermission	5	--	--
Rinsing	10	100	2,750
Filteration	--	100	--

The operation of the plant usually requires 130lb/day of alum, 130lb/day of slaked lime, and 20lb/day of chlorine.

Alum is taken from storage every other day, and is stored in the form of solution in the solution tank. Slaked lime will also be fed into the chemical feeder every other day. A thirty day supply of the chemicals should be kept in reserve, and operators should wear chlorine gas masks and gloves.

The treatment plant site and the place of intake should be kept clean at all times.

A two years supply of spare parts for maintenance and management is necessary.

4-7-3 Electrical Concerns

If changes of more than ± 10% are induced in the provided voltage and cycle, the low voltage relay and overcurrent relay will react automatically to stop the operation of the Plant in order to protect it. For this reason, the voltage regulation of the provided power must be kept under ± 10%.

4-8 Expansion Plan

As referred to in the preceding chapter, this scheme is of the scale which will meet the demand.in 1980, and therefore, will have to be expanded in 1995. With this expansion in view, all pump rooms are designed to allow space for future installation of an increased number of pumps. A full allowance is also made in the acreage of the site for future expansion of the flocculator the sedimentation basin, the filter and the reservoir.

The present scheme has chosen an area of a high-population density for the service area, but in order to be able in future to supply water to the Sura area (part of which is included in the present scheme) and Kg. Telok Bedara, as well, the scheme has given full consideration to connection points.

Electricity is designed so the receiving equipment already has capacity to meet future expansion and the tie cable has the necessary number of cores that will be needed after the expansion. The boards (panels), have enough space in reserve to be fitted with the necessary instruments. (Except the operation board of the filter basin, which will be replaced.

4-9 Power Plant (alternative suggestion)

Although Malaysia and our commission have reached an agreement concerning the power supply of the plant as presented in 4-6 and 4-7 the following suggestion is presented as an alternate plan because it is felt that it is more advantageous to have the affiliated power plant for the Plant from the view point of economy as well as stability, though it may be more difficult from the stand point of management.

The plant will consist of a diesel engine, generator, oil feeder, and fuel oil tank. It will produce the 108 KVA necessary under the 1980 plan, and its possible expansion to produce 195 KVA under the 1995 plan is left for future consideration. The voltage and cycle will be 440V and 50 cycles following the Malaysian standard. The power is directly given to the receiving incoming power board of the treatment plant. A part is transformed to 3,000V and sent to the distant incoming power board at the place of intake. The construction of the power plant requires, in addition to the above, 130 square yards of land. As power plant construction cost, the sum of M$225,800 is required.

4-9-1 Diesel Engine Generator.

2 sets (one of which is for spare)

1. Diesel engine :

Type :	vertical 4-cycle diesel engine.
Number of Cylinder ;	6.
Continuous rating output :	150 P.S.
Revolution ;	1,500 r.p.m.
Combustion system ;	Pre-combustion chamber system.
Lubrication :	Forced lubrication by a gear pump.
Cooling :	Forced circulating water-cooled system.
Starting :	Self-starter
Fuel and its Consumption :	
	Heavy oil --- 0.44 lbs/ps. /hr.

2. Generator :

Type :	Open protective type.
Output :	125KVA
Phase :	3
Voltage :	440V.
Frequency :	50 c/s
Power factor :	80% lag
Pole :	4.
Revalution :	1,500 r.p.m.
Excitation :	Self-excitation by a static exciter

3. Generator board :

Type :	Enclosed self-support system.
Attachment ;	Voltmeter,
	Ammeter,
	Power factor meter,
	Watt Meter,
	Circuit breaker,
	Protective relay,

4. Period checking board :

Type :	Blacket panel.
Attachment ;	Voltmeter,
	Frequency meter,
	Checker

5. Accessories :

Exhaust silencer,
Exhaust flexible pipe,
Fuel tank (100 gal.)
Fuel flexible pipe,
Fuel stand
Battery, DC 24V. 150 AH
Silicon rectifier for charging the above,
Anti-shock rubber,
Standard tools.

6. Spares (for two years)

Nozzle
Pre-combustion chamber packing
Piston ring
Exhaust valve with spring
Plunger spring
Rubber packing for cooling water
Discharge valve for use on a fuel pump
Volt pin for rods
Fuel pump plunger
Discharge valve for a fuel pump
High pressure fuel pipe
Governor spring
Gasket packing

7. Wirings for power

4-9-2. Auxiliary equipment ;

1. Fuel storage tank :

Type : Cylindrical horizontal, steel plate.

Capacity : 2,200 gal. (for ten days)

Accessories : Oil gauge,
Piping and valve for receiving heavy oil,
Air vent pipe,
Fuel drainage valve.

2. Exhaust duct.

3. Chain block

Capacity : 3 tons.

Accessories : I-beam

4. Oil feeding piping and Cooling-water piping.

4-9-3 Generator house ; a complete set.

Acreage : 120 square yards.

4-9-4. Power Plant Construction Cost

Total Amount ; M$225,800

Chapter 5. Construction Work.

This report is concerned with only essential details, it is therefore necessary to carry out as soon as possible investigations and preparatinn concerning details that accompany the construction work.

5-1 Intake Tower.

In designing water-source facilities, in particular, the Highest High Water Level and the Lowest Low Water Level have been determined in our survey taken at the site on the basis of the findings of the field survey. As shown in the drawing., HHWL was determind 1 foot higher than the flood level which had taken place in January, 1967, and which had been the highest experienced during the past 5 or so years by the local inhabitants, and LLWL at 1 foot lower than the lowest level we witnessed during the period of our survey which took place on January 13, 1967. The HHWL and LLWL thus determined have been taken for the high and low water levels, respectively, of the intake tower. From now on these high and low levels should be studied after which full consideration should be given in putting the construction work in practice.

In constructing the intake tower, the well sinking method is to be adopted. In sinking a well, the wall of the well is worked while surrounding earth and sand are prevented from sliding. Uneven sinking which may take place while it is being worked may cause the well crib to tilt, creating, a unexpected stress. Therefore, in designing, consideration must be given to the arrange ment of reinforcing steel and the thickness of the wall, and to prevent uneven loading on the sinking load or to prevent uneven sinking of the well crib due to the use of a submarine excavator, through supervision of work.

It is recommended that the mould of the rod of the well (including curve shoe) be made of steel plate, by keeping its length level with the water surface and by floating and transporting it, to install the primary rod.

5-2. Construction Schedule.

We recommend that the construction work be carried on according to the construction schedule attached. It is desirable that the completion of work be fixed at two years as shown in the schedule, and the contract based on the term of work be arranged as follows :

(1) Supply and Installation.

(a) Supply and installation of instruments, mechines and electrical equipment necessary to intake and filter facilities and accessory connection pipes and special pipe joints.

(b) Supply of penstocks,. rising pipes, distributing pipes, joint special pipes, and a complete set of valves.

(2) Civil Engineering Works and Pipe Laying Works.

(a) Civil engineering works on the intake tower, reservoir, the filter plant and other structures.

(b) Work on pipe laying except that under (1)-(a).

5-3 Despatch of Engineers

In carrying out the construction work, we recommend despatch of the following technicians, taking into consideration special methods of working on water-source facilities, the siphon culvert work for laying the distribution pipes across rivers, and chemical tests attendant on a trial operation.

Engineer & Technician	Person	Term (Month)
Civil Engineer	1	4
" Technician	1	5
Mechanical Engineer	1	5
" Technician	1	6
Chemical Engineer	1	4
" Technician	1	5

Expenses for despatching the above technicians are estimated as M$172,000, apart from the construction costs.

5-4 Designing

M$72,000.00 will be necessary for designing in addition to the construction cost. This sum does not include expenses for soil quality tests and various surveys in case the construction site is changed.

Chapter 6. Cost of Construction and Maintenance

6-1 Construction Cost

6-1-1 Intake and Rising Main

Machinery, electric equip. & instrument	M$78,200
Piping, valves & fittings	85,900
Civil works	134,900
Sub-total	M$299,000

6-1-2 Treatment Plant

Machinery, electric equip. & instrument	M$314,800
Piping, valves & fittings	71,700
Civil works	283,300
Sub-total	M$669,800

6-1-3 Supply Mains

Machinery, electric equip. & instruments	M$22,300
Piping, valves & fittings	20,200
Civil works	5,300
Sub-total	M$47,800

6-1-4 Distribution mains

Machinery, electric equip. & instrument	M$26,000
Piping, valves & fittings	395,900
Civil works	291,700
Sub-total	M$713,600
Total	CIFM$1,730,200

6-1-5 Unloading Fee and Transportation

Sub-total	M$67,342
Grand Total	M$1,797,542

6-2 A Breakdown of Construction Cost

6-2-1 Construction Expenses

	Machinary, electric equip. & instrument	Piping, valves & fittings	Civil works
Intake and Water Rising Mains	M$ 78,200	M$ 85,900	M$ 134,900
Treatment Plant	314,800	71,700	283,300
Supply Mains	22,300	20,200	5,300
Distribution Mains	26,000	395,900	291,700
Sub-total	441,300	573,700	715,200
Total			M$1,730,200

6-2-2 A Breakdown of Construction Funds

	Foreign funds	Domestic funds	Total
Intake and Water Rising Mains	M$ 164,100	M$ 134,900	M$ 299,000
Treatment Plant	386,500	283,300	669,800
Supply Mains	42,500	5,300	47,800
Distribution Mains	421,900	291,700	713,600
Unloading Fee and Transportation Costs	--	67,342	67,342
Total	M$ 1,015,000	M$ 782,542	M$ 1,797,542

6-3 A Breakdown of Estimated Construction Cost

	1969	1970	Total
Intake and Water Rising Mains	M$ 225,700	M$ 73,300	M$ 299,000
Treatment Plant	400,000	269,800	669,800
Supply Mains	47,800	--	47,800
Distribution Mains	192,700	520,900	713,600
Total	M$ 866,200	M$ 864,000	M$ 1,730,200,

6-4 Operation and Maintenance Cost

6-4-1 Personnel Expenditure

Type of work	Number of workers	1 shift	3 shifts
Superintendant	1	16.00M$/D	16.00M$/D
Senior attendant	3	8.67	26.00
Junior attendant	3	5.58	16.75
Pump operator	1	5.33	5.33
Worker	1	4.67	4.67
Total	9	40.25	68.75
Total (year)		M$14,691.25	M$25,093.75

6-4-2 Power Cost

(1) Power, Consumed (21-hour operation)

Apparatus	Wattage	Number of apparatus	Time	Power, consumed
Intake pump	30.0KW	1	21Hr	630.0 KWH/D
Rapid saturation apparatus	2.2	1	21	46.2
Alum	0.75	1	0.5	00.4
Lime injector	0.2	2	21	8.4
Flocculator	1.5	2	21	63.0
Supply pump	37.0	1	21	777.0
Air compressor	1.5	1	7.0	10.5
Illumination and calculating apparatus	20.0	1	8.0	160.0
Total				1,695.5 KWH/D

(2) Power Cost

(a) Operating hours per day 21 hours

(b) Power consumption per day 1,695.5 KWH/D

(c) Unit power cost between 6.30 P.M. and 9.30 P.M.
MCent 21 / KWH

Unit power cost between hours other than the above hours.
MCent 7.5/KWH

(d) Power costs

(1) Cost for 18 hours $\frac{18}{21} \times 1,695.5^{kwh} \times 7.5^{cents}$

$= M\$109^{\underline{00}}$

(2) Cost for 3 hours $\frac{3}{21} \times 1,1695.5^{kwh} \times 21$ cents

$= M\$50^{\underline{87}}$

(3) Total ((1) + (2)) $M\$159.^{\underline{87}}$/Day

(4) Power cost per year

$159.^{\underline{87}}$ /D x 365^{d} = $M\$58,352.^{\underline{55}}$/year

6-4-3 Chemical

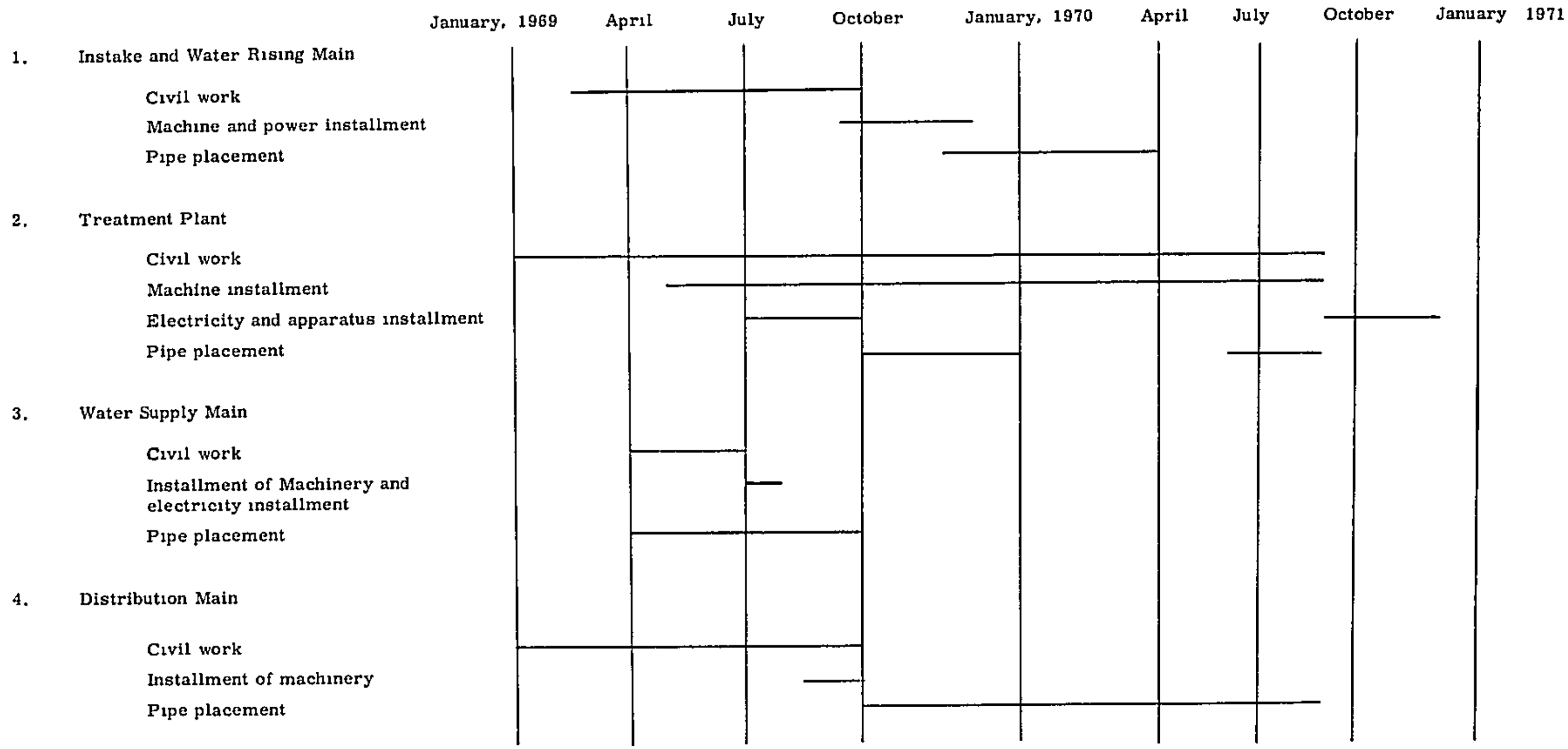
	Daily consumption	Unit cost	Chemical cost
Alum	130 lbs/D	0.088 M$/lb	11.48 M$/D
Slaked lime	130 lbs/D	0.069	8.99
Chlorine	20 lbs/D	0.70	14.00
Total			34.47 M$/D
Total cost of chemicals yearly		M$12,559.65	

6-4-4 Unit Cost of Water Supply

Labor Cost	M$25,093.75
Power Cost	58,352.55
Chemical Cost	12,559.65

Total	M$96,055.95
Per day	263.03
Per gallon	0.0004/gal
Per 1,000 gallons	0.40/1,000 gal.

Table of Construction Work Plan (Dungun)



Chapter 7 Financial Plan, Water Charge, and Others

The financial plan is shown in a seperate table. In its preparation, Malaysia expresed agreement to the following points:

(1) Repayment will be made in equal installments over a 30-year period, with a 5.75% interest rate.

(2) A financial plan will be prepared which covers a ten-year period from the date the water supply begins.

(3) Water charges will be M$1.00 per 1,000 gallon.

(4) Operation and maintenance cost collection covers every expenditure including the collection of water charge.

(5) Two percent of the total construction cost will be included in the provision for replacement and minor extension.

SCHEDULE OF ESTIMATED SUPPLY, REVENUE AND EXPENDITURE

(DUNGUN)

1	2	3	4	5	6	7	8	9	10	11
Year	Estimated supply per day in 1,000 gals.	Estimated supply for the year 1,000 gals.	Estimated Revenue M$	Present Worth of Revenue M$	Repayment of Capital M$	Operation and Maintenance Cost M$	Provision for Replacement & Minor Extension M$	Total Expenditure for the year M$	Present Worth of Total Expenditure M$	Remarks (Balance in Present Worth) M$
1971	438	160,045	160,045	150,842	127,081	67,219	35,951	230,251	217,012	-66,170
1972	447	163,009	163,009	144,801	127,081	68,464	35,951	231,496	205,638	-60,837
1973	455	165,973	165,973	138,953	127,081	69,708	35,951	232,740	194,850	-55,897
1974	463	168,937	168,937	133,308	127,081	70,954	35,951	233,986	184,638	-51,330
1975	471	172,371	172,371	128,192	127,081	72,395	35,951	235,427	175,087	-46,895
1976	479	174,864	174,864	122,562	127,081	73,443	35,951	236,475	165,745	-43,183
1977	487	177,828	177,828	117,473	127,081	74,687	35,951	237,719	157,037	-39,564
1978	495	181,287	181,287	112,869	127,081	76,141	35,951	239,173	148,909	-36,040
1979	503	183,756	183,756	107,828	127,081	77,177	35,951	240,209	140,955	-33,127
1980	512	186,719	186,719	103,274	127,081	78,422	35,951	241,454	133,548	-30,274

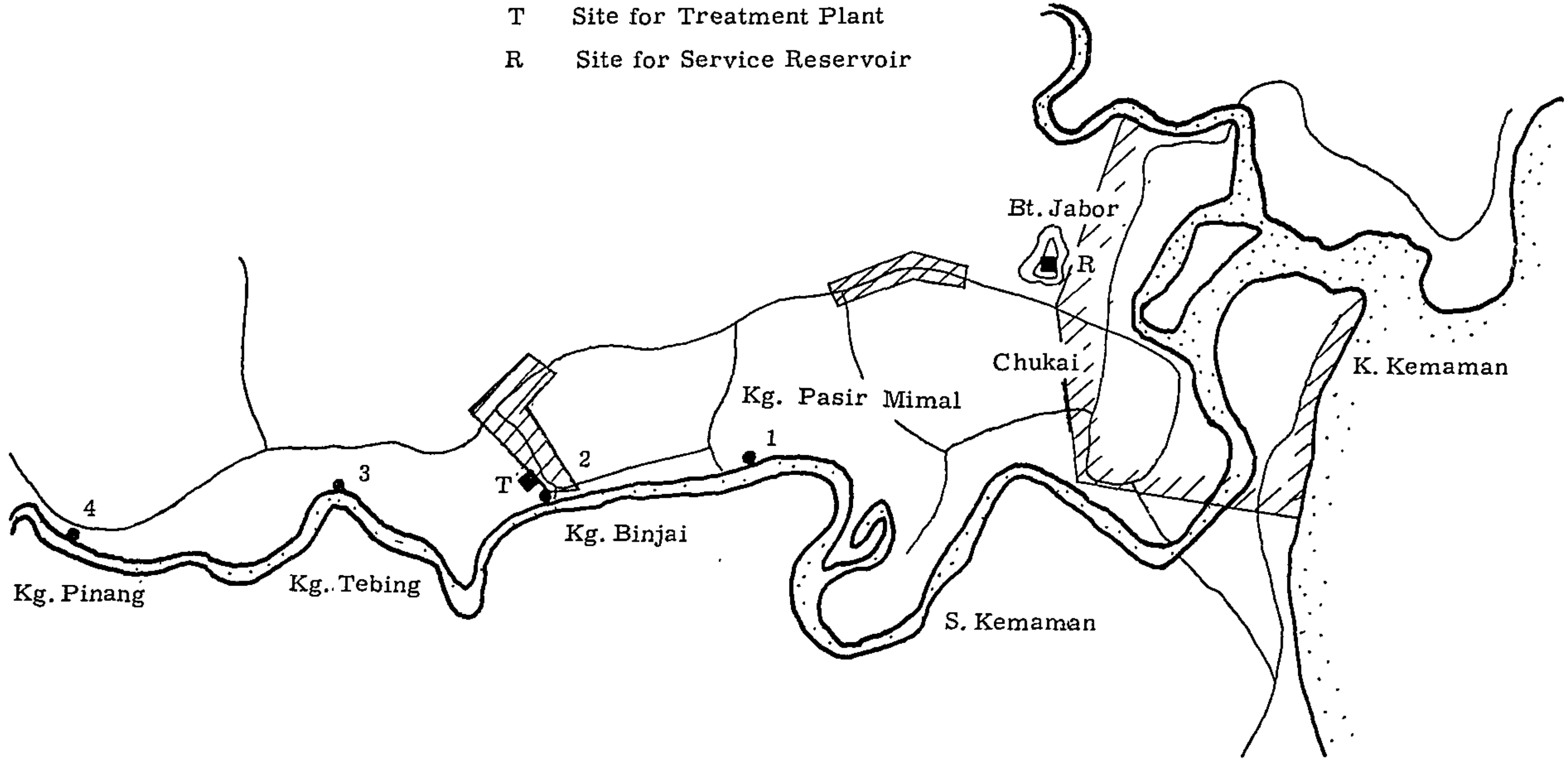
KEMAMAN

Fig. 3-1 KEMAMAN WATER SUPPLY

1 - 4 Alternative Water Sources

T Site for Treatment Plant

R Site for Service Reservoir



Part IV. Water Supply Plan in Kemaman

Chapter 1. General Outline

Chukai Town is situated in the south of Trengganu State on National Highway No. 3 which runs along the east coast and on the estuary of the Kemaman River. It is about 40 miles to Dungun which is in the north of the State and 30 miles to Kuantan in the south. Chukai is the capital of Kemaman District, and like Dungun, it is, with governmental agencies, the center of economy, politics and communication.

Unlike Dungun, which has attained rapid development, Chukai has been slow but steady in its development. The main industry is agriculture, specializing in the cultivation of palms on the plain in the rear. Forestry and fishery are among other growing industries.

Fishery is, in particular, very active. In the event of the water work is established, it is expected that an ice manufacturing and refrigerating plants will be established.

The population of Chukai showed a 30% increase in ten years from 1947 to 1957, and that of the Town Board, which includes Kuala Kemaman, made a 20% increase, which was close to the 23% registered by Trengganu, in the same ten years.

Chapter 2. Outline of the Water Supply Plan

2 - 1. Supply Areas

As is shown in Fig. 3-1, the supply areas will be limited to the Chukai Mukim Area that includes the Chukai Town Board, Kg. Kemaman, and Binjai Mukim along the water supply pipeline. Small villages along the third national highway that runs from north to south, the Telok Kalong area to the north, Chukai River and Kg. Gellga Besar in the south, will be excluded from the plan. This exclusion is based on our intention to highten the economic effect of the plant.

2 - 2. Population To Be Served

Concerning the population in the supply area, the only available data was the 1957 national census statistics that showed the Chukai Town Board had a population of 10, 803. Therefore, it was decided to employ the figure of the present population presented by Mr. Hasim bin Sulaiman, the Kemaman District Officer, as the most reliable statistics.

The present population in the supply area is as follows;

Chukai Town Board	15, 300
Kg. Kemaman	5, 000
Total of Chukai Mukim	20, 300
Binjai Mukin	1, 420

The 1967 population of 15, 300 of Chukai Town Board shows a 41. 6% increase when compared with the 1957 population of 10, 803. This rate of increase is almost equivalent to the rate of increase from 1947 to 1957, the highest rate in the whole of Malaya.

As stated in former chapters, economic expansion in Chukai Town is rapid and if the water supply plant is constructed, the area can expect to have such new industries as ice and frozen food manufacturing factories. So, it is expected that the population of Chukai Mukim Area will grow from now on with a 4.2% rate of increase.

The population of the Binjai Mukim Area does not seem to grow as rapidly as Chukai Town. Accordingly, the 2% estimated rate of increase is a little lower than the 2.3% of 1947 - 1957 rate of increase in the state of Trengganu.

With the above rates, it is estimated that the future population in the water supply area will be 33,200 in 1980, and 46,400 in 1995.

2-3 Expected Supply

The P.W.D. statistics of 1965 show the daily water consumption per person in Malaya as follows:

The Average of the Whole of Malaya	30.86G.
The Average in Prak, Kelantan, Pahang and Trengganu States	26.54G.
The Average in Kuala Trengganu	28.00G.

The above figures are the avarages of consumptions both in provincial areas and city districts. And, the first two figures are the averages of the water consumptions of the various plants, large and small, old and new, installed in the area.

In the Chukai Town Area there is no industry that requires a large amount of water at present, but, as stated above, the area can be expected to develop such industries when the water supply plant is constructed, and a drainage system is installed in the future.

Taking the above conditions into consideration, it has been decided that the daily water consumption per person is 30G. under the 1980 plan, and 35G. under the 1995 plan, which is more than that of Dungun Area that is :

In 1980 30G. x 33,200 (population) = 996,000G.

In 1995 35G. x 46,400 (population) = 1,624,000G.

The first objective of our plan is to procure the planned water supply of 1980 with the highest economic effects based on reality. The 1980 plan is made in consideration of facilitating the future 1995 expansion.

The design of distribution pipes : for the rural district in the supply area, it was estimated that the daily water supply per person would be 18 gallons in 1995; the pipes were designed accordingly for better economic effects.

Chapter 3. Water Source

3-1 Standards of Water Quality

There has been no standard of water set for watersupply in the Federation of Malaysia. In selecting water sources, first, the critical nature of the water allowed for water supply should be set. On this subject, at the first consultation between the Malaysian Government authorities and our investigation team held on August 24, 1967, P.W.D., Ass. Director Mr. Chong wished that the critical nature would be based on the standard of W.H.O. (World Health Organization). Our survey and all schemes based on our survey should, accordingly, be such as well satisfy the standard* of W.H.O. as shown in Table 3-1.

* W.H.O.; International Standards for Drinking Water, P. 206(1963), Geneva.

3-2 Water Sources and the Intake Points

3-2-1. Selection of Water Sources.

Upon examining the results of the geological survey made of this area by the Geological Survey Department in 1962, it was concluded that it was almost impossible to expect of this area a sufficient amount of well water required for the water supply. As the result of our examination of the analytical value of the well water as given in Bolton Report*-1, it was judged that since this water contains much sulphate ion, is high in hardness, very low in PH, and is strongly impregnated with iron, it would involve, economical and technical difficulties to maintain the standard values of W.H.O., and it was thus disqualified as raw water for water supply. Thereupon, we examined the surface water of the River Kemaman as to its suitability as raw water for water supply.

The results of the analysis made of the water collected at No. 2 point (kg.[*-2] Binjai landing place) as shown in Fig. 3-1, at 9:45 on

Table 3-1 Water Quality Standards for Drinking Water

	W.H.O. Standard	Japan Standard	U.S.A. Standard	W.H.O. (in Europa) Standard	England Standard
Coliform groups		never detected in 50 ml	Positive samples: not more than 10% in a month	Not more than 15 samples in 100 samples (100ml)	There are no particular standards.
Number of bacteria		Not more than 100 in 1ml.			
Odor		Must not be	3*		
Taste		abnormal	must not be abnormal.		
Colour		5*	150*		
Turbidity		2*	5*		
Total solid		500 ppm	500 (1,000) ppm		
pH value	7.0-8.5 (6.5-9.2)	5.8-8.6			
Total hardness	100-500 ppm *	300 ppm *		100-500 ppm	
Potassimn permanganate consumed.	10 ppm	10 ppm			
Chloride ion	200(400) ppm	200 ppm	250 ppm	350 ppm	
Sulphate ion	200(400) ppm		250 ppm	250 ppm	
Ammonia Nitrogen	0.5 ppm	never detected		0.5 ppm	
Nitrite Nitrogen		at the same time			
Nitrate Nitrogen	40(80) ppm	10 ppm	45 ppm	5.0 ppm	
Lron	0.3(1.0) ppm	0.3 ppm	0.3 ppm	0.1 ppm	
Manganese	0.1(0.5) ppm	0.3 ppm	0.05 ppm	0.1 ppm	
Fluoride	1.0(1.5) ppm	0.8 ppm	0.6-1.7 ppm	1.5 ppm	
Lead	0.1 ppm	0.1 ppm	0.05 ppm	0.1 ppm	
Arsenic	0.2 ppm	0.05 ppm	0.01(0.05) ppm	0.2 ppm	
Selenium	0.05 ppm		0.01 ppm	0.05 ppm	
Hexavalent chromium	0.05 ppm	0.05 ppm	0.05 ppm **	0.05 ppm	
Copper	1.0 ppm	1.0 ppm	1.0 ppm	0.05 ppm	
Zinc	5.0(15.0) ppm	1.0 ppm	5.0 ppm	5.0 ppm	
Phenol	0.001 (0.002) ppm	0.005 ppm	0.001 ppm	0.001, ppm	
Cyamide	0.01 ppm	never detected	0.01 (0.2) ppm	0.01 ppm	
Mercury		never detected	0.05 ppm		
			1.0 ppm		
Cadmium			0.01 ppm	0.005 ppm	
A.B.S			0.5 ppm	take care of the concentration	
Radioactivity	Dray 10^{-a} μc/ml Bray 10^{-8} c/ml		Ra. 225, 3μμc/l ayear Sr. 90, 10μμc/l a year Total B, 100μμc/l a year	Dray 1μμc/l Pray 10μμc/l	
Organic Phosphorus		never detected			
Free residual chloride		not under 0.1 ppm	0.05-0.1 ppm		
Magnesium	50(150) ppm				
Calcuim	75(200) ppm	* as $CaCO_3$	* as No_4		
	( )· when unavoidable * as $CaCO_3$ * as NO_3	** changing to 0.05 ppm *** changing to 0.5 ppm	** sexivalent ( ), when unavoidable. There are others Such as Silver ; 0.05 ppm Activalted Carbon , 0.2 ppm Chloroform extraction quantity , 0.2 ppm.		

Table 3 -2

Chemical Analysis of Samples of Sungei Kemaman

Alternative Site Number and Location of Sampling

No. 2 The Ferry at Kg. Binjai

Date & Time of Sampling 09.45 of 10th September, 1967

Appearence	Brown
Water Temp. (°C)	26
Turbidity	100 - 150
PH	7.2
M-Alkalinity as $CaCO_3$	8.0
Chloride as cl	5.0
Total Iron as Fe	0.8
Total Hardness as $CaCO_3$	4.0
Chemical Oxygen Demand (30 minutes 100°C)	8.0
Ammoniacal Nitrogen	+
Nitrite Nitrogen	+

All Values in Parts per Million

Testing Method: based upon JIS K0101

Table 3 -3

Coagulation Test

Run	1	2	3	4	5
Alum as 14% Al_2O_3	0	10	15	20	30
PH after Alum Dosing	7.2	6.2	5.6	5.2	4.9
Sodium Hydroxide as $CaCO_3$	0	3.4	5.0	7.0	11.0
PH after Sodium Hydroxide Dosing	7.2	7.0	7.1	7.1	7.3
Floc Formation	–	–	+	++	+++
Filtrate after Coagulation					
Turbidity	Ca 20	10>	2>	2>	2>
Color	Ca 30	10>	3>	3>	3>
Total Iron as Fe	0.3	0.3	0.3		
Chemical Oxygen Demand as O (30 minutes 100°C)	8.2	7.7	5.1		

All Values in Parts per Million

September 10, 1967, were given in Table 3-2. As is clear from Table 3-2, the features of the samples lay in high turbidity and in the lowness of alkalinity, hardness and iron contents, and in that they were little contaminated with organic matters. It may be said, of the water in question that if it is possible to prevent salinity getting mixed, the expected salinity mixing which takes place under tidal influence, it is good for water supply and for industrial use alike. Table 3-3 shows the results of its coagulation tests. The table shows that the water can be treated with relative ease to satisfy the standards of W.H.O.

*-1. Bolton Hennessey Coagan & Associates; Report on a Proposed Water Supply to Kemaman.

*-2. The abbreviation for "Kampong", which corresponds to "Buraku, (or Village)" in Japan.

3-2-2. Selection of an Intake Point.

(a) Tidal levels, rainfall, and the quality of water.

In the preceding section, it has been concluded that the water from the River Kemaman is good both for use for water supply and for industrial use, if salinity is prevented from mixing. During the period of our field survey, with the idea of checking the tidal influence on the proposed intake site we carried out continuous surveys and measurements on September 4, 1967, when the tidal level in the River Kemaman was to be the highest (the highest in September), of the quality of water and the water levels at No. 1 point (Kg. Pasir Minal) and No. 2 point (Kg. Binjai), and a water analysis at No. 3 point (Kg. Tebing) and No. 4 point (Kg. Pinang) at the hour when the tidal level was to be highest. The results are shown in Fig. 3-2 & Table 3-4. As is clear from Fig. 3-2 & 3-3, tidal influence is great at points No. 1 and 2. If water of less than 200ppm of chloride ion concentration is to be taken in at these points, intake of water

Fig. 3 -2

TIDE HEIGHT, CHLORIDE ION
v.s. TIME
(Sep. 4, '67,
KG. PASIR MINAL)

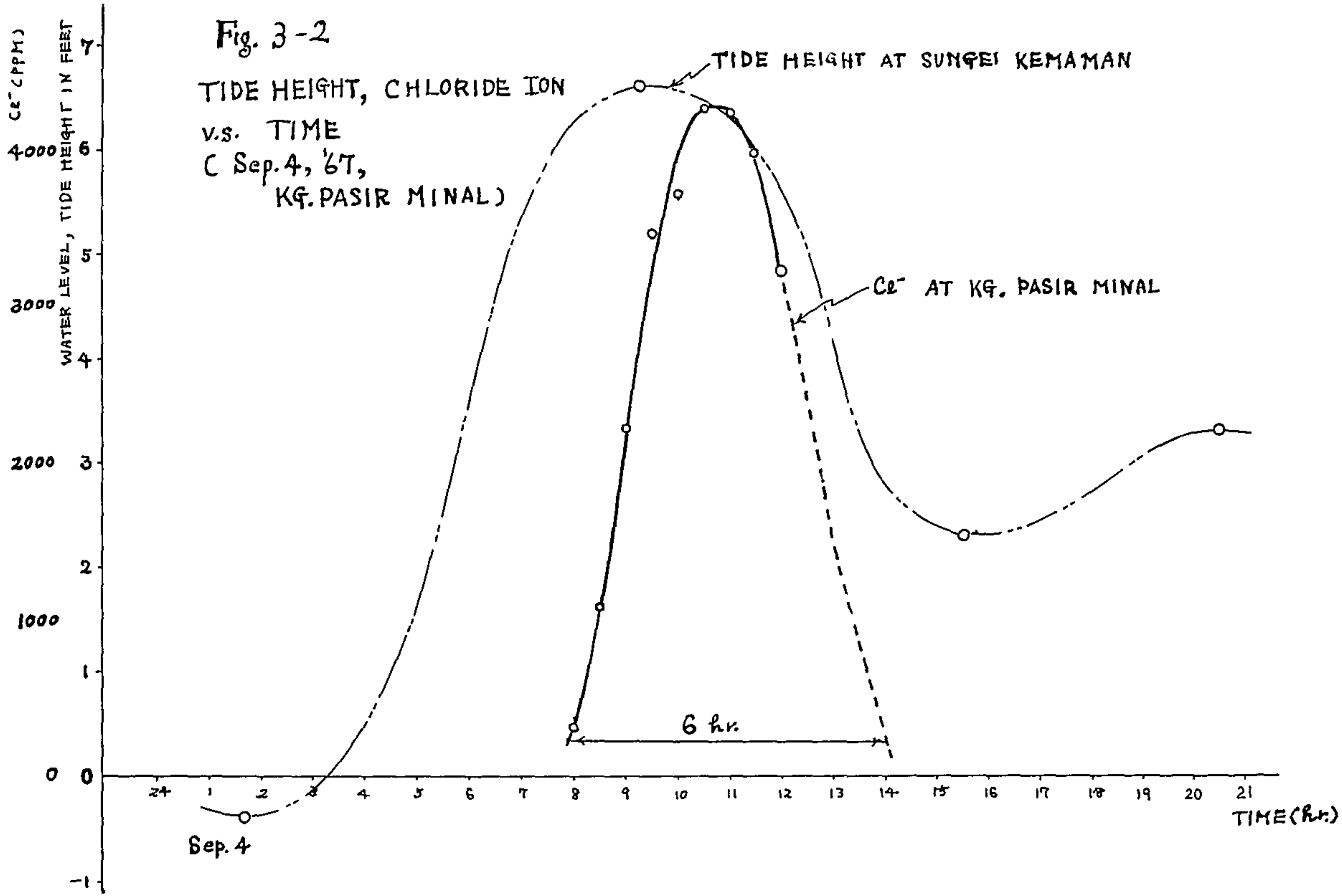


FIG. — 3.3 TIDE HEIGHT, CHLORIDE ION V.S TIME (SEP. 4,'67, KG.BINJAI)

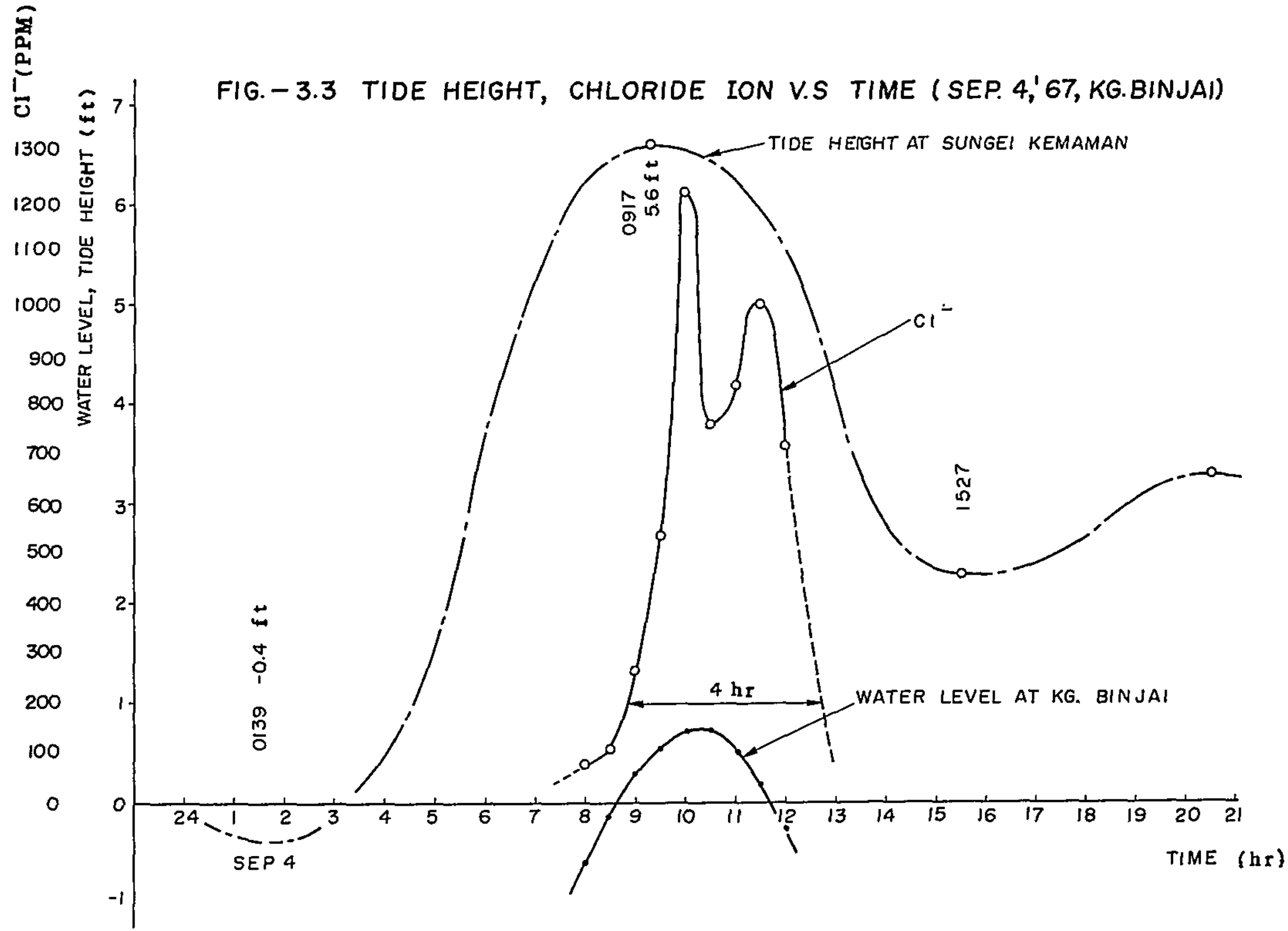


FIG. 3.4 TIDE HEIGHT, CHLORIDE ION V.S. TIME
(SEP. 11, '67, KG. BINJAI)

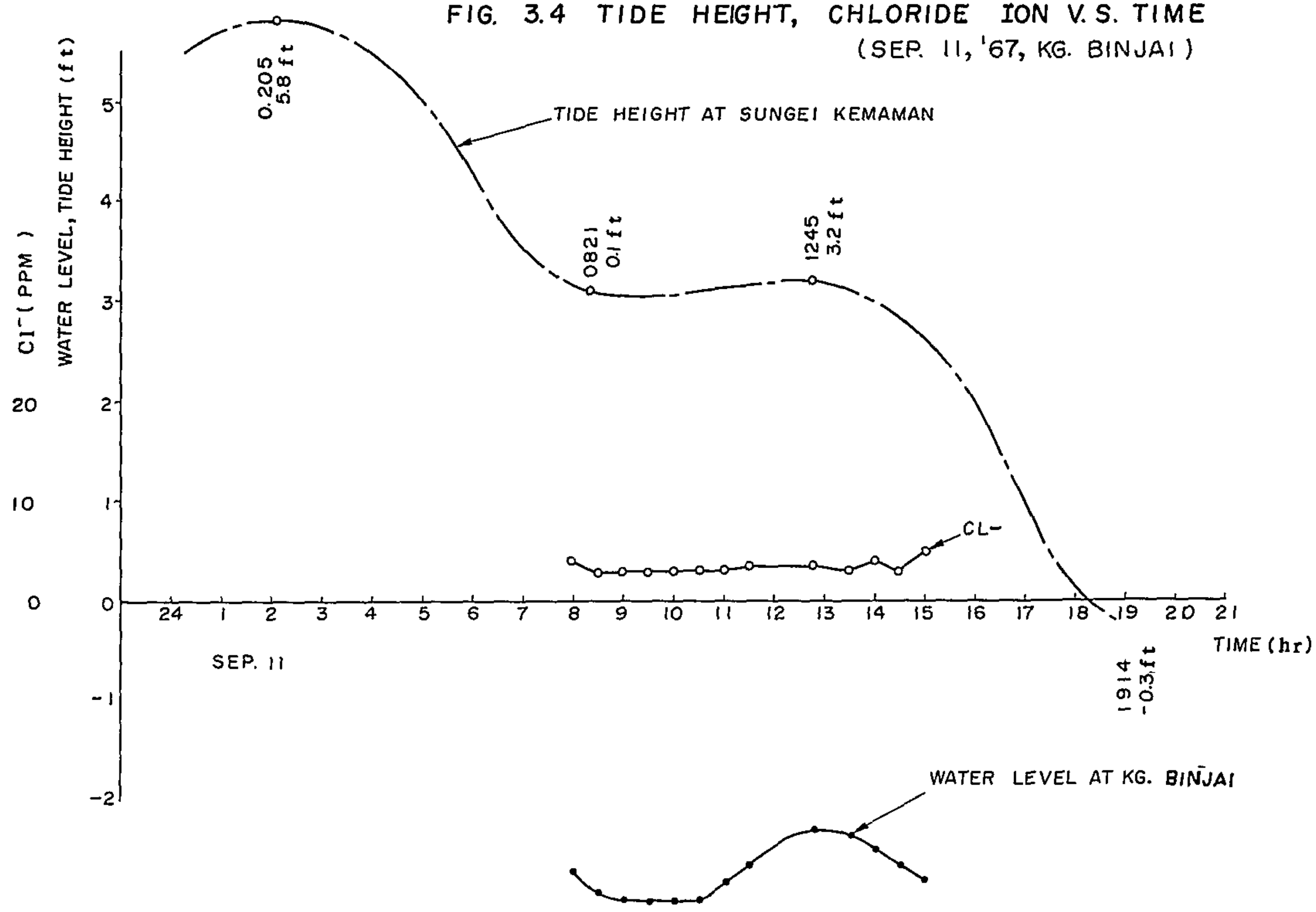
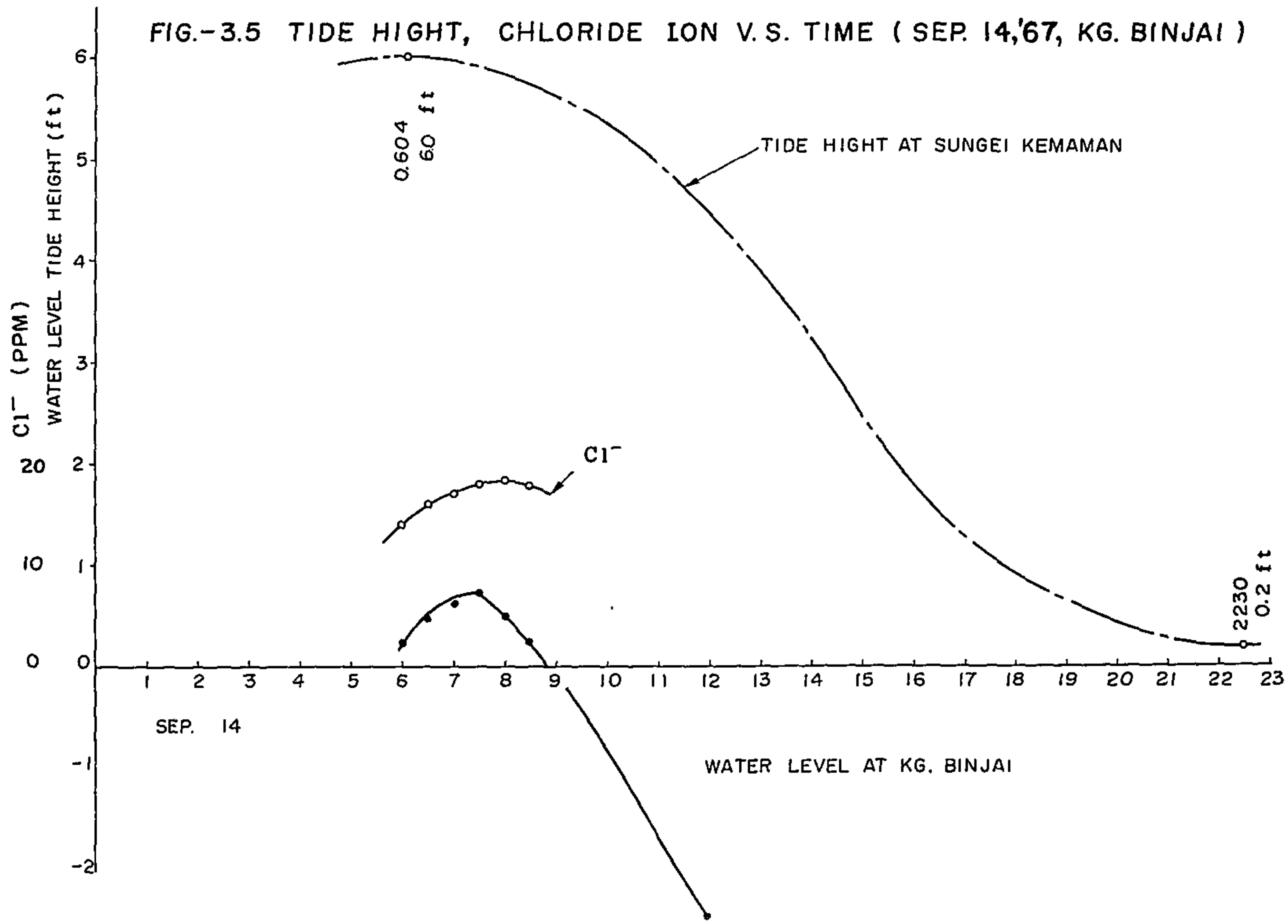


FIG.-3.5 TIDE HIGHT, CHLORIDE ION V.S. TIME (SEP. 14,'67, KG. BINJAI)



Chemical Analysis of Samples of Sungei Kemaman

Date : 4th September, 1967

Alternative Site Number and Location of Sampling	Time (hr)	Chloride (ppm as Cl)	PH
No. 3 Kg. Tebing; about $1\frac{3}{4}$ miles up stream from No. 2	10.00	46	6.8
No. 4 Kg. Pinang; about $2\frac{1}{8}$ miles up stream from No. 3	09.25	9	7.0

FIG.- 3 6 MOTHLY H.H.W & L.L.W

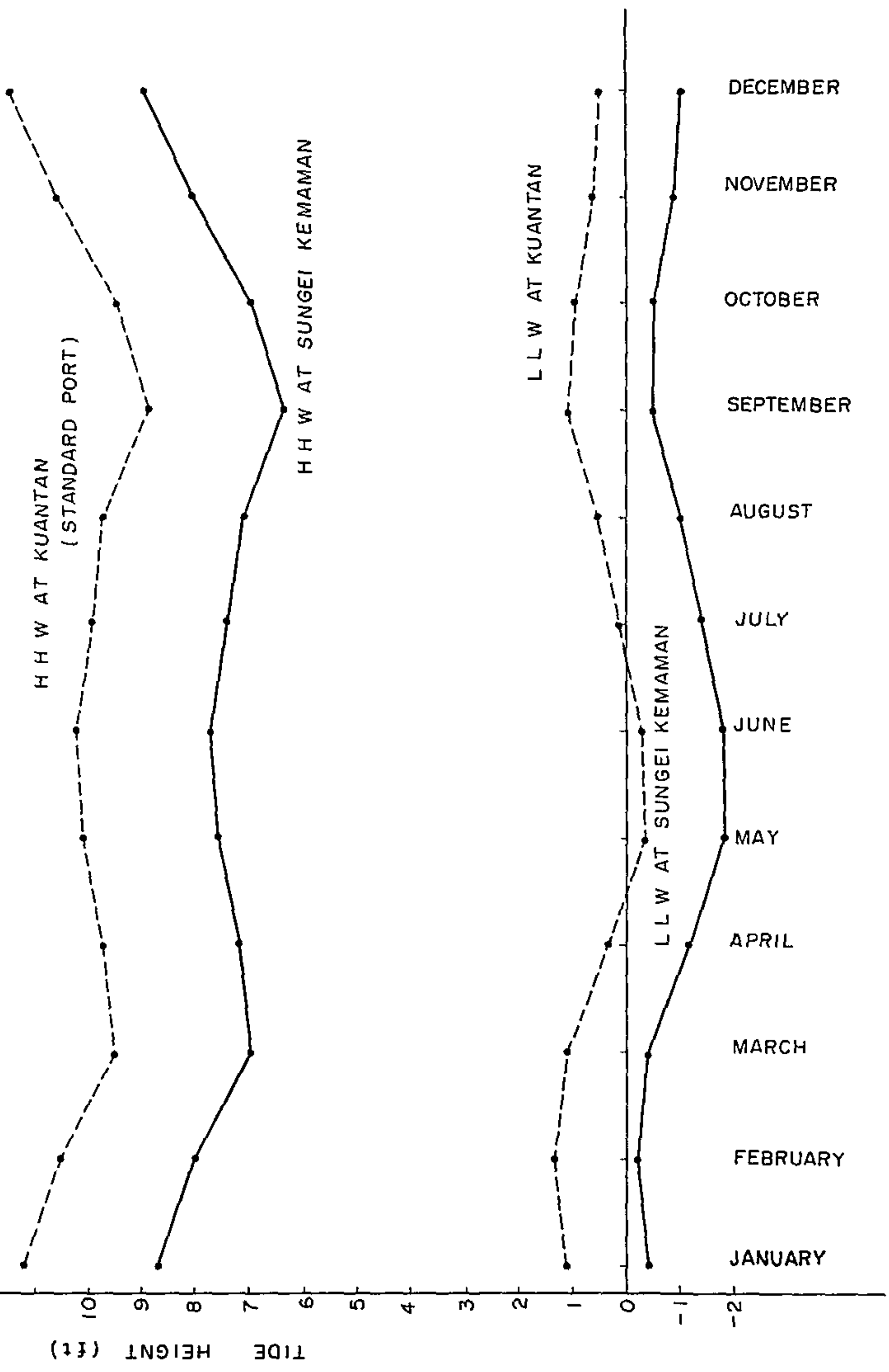
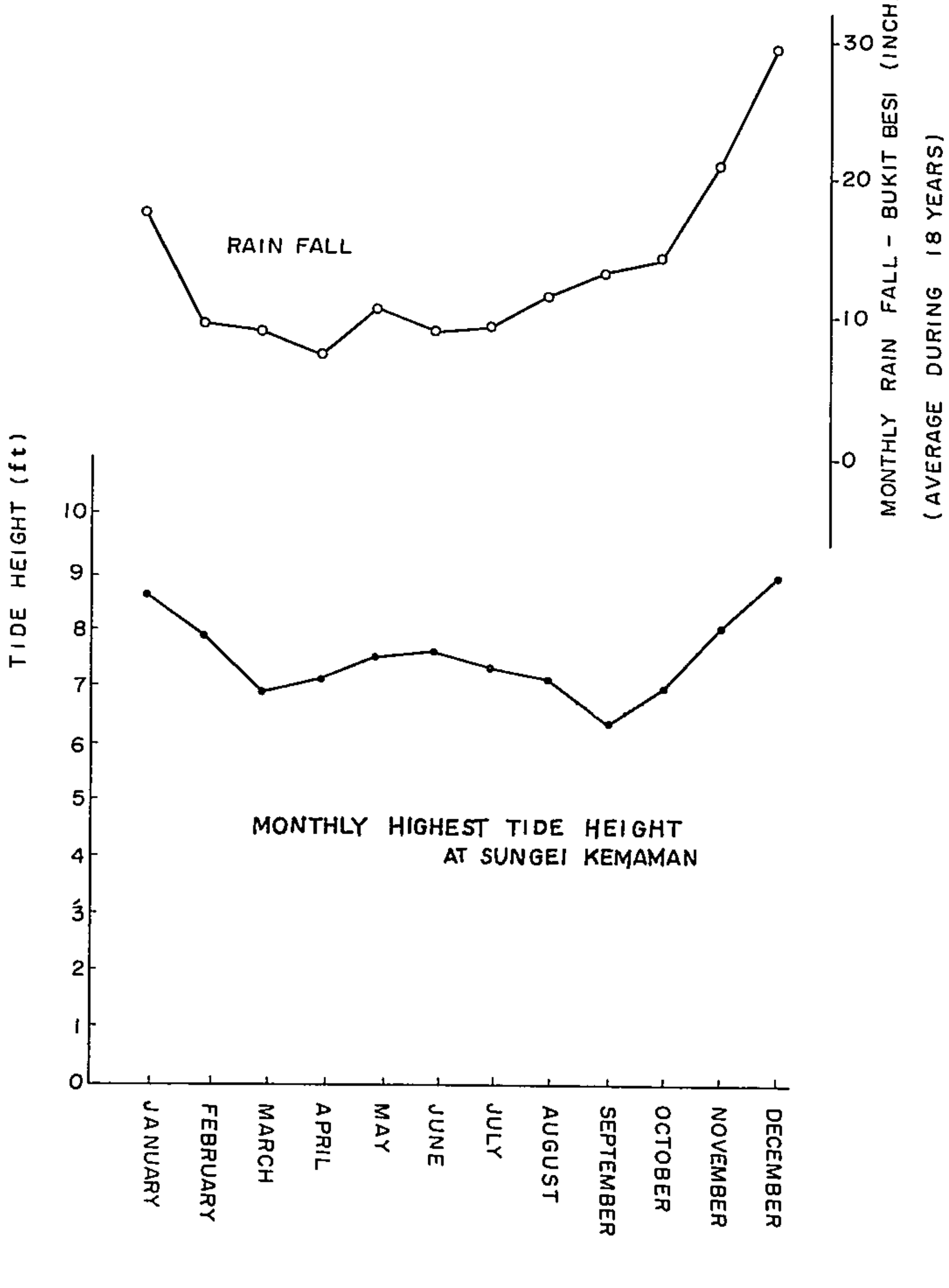


FIG. - 3.7 MONTHLY RAIN FALL AND H. H. W
AT SUNGEI KEWAMAN



will have to be suspended for about 6 hours at the former and about 4 hours at the latter. Tidal influence is felt slightly at point No. 3, and at No. 4 no influence is felt at all. Fig. 3-4 & 3-5 show relation between the tidal level and chlorine ion contents at point No. 2 on September 11 and 14, 1967. Examination into the relation between the tidal level and chloride ion on September 3, Fig. 3-3, when the tidal level was highest for September, will clarify that chloride ion is small in quantity for high tidal level.

As described above, we have learned how the quality of water of the River Kemaman was related to its tidal level during the period of our survey. From the stand point of deducing relations between the tidal level and the quality of water throughout the year, we calculated, based on the tide table[*-1] we had obtained on the site, the highest and the lowest tidal level of the River Kemaman for each month of 1967. The results are given in Fig. 3-6.

On the assumption that the rainfall in this area is almost equal with that in Dungun, we gathered from the data of E.M.M. C.O.[*-2] that the relation between the monthly average rainfall and the monthly highest tidal level, the result of which is shown in Fig. 3-7.

The smaller the distance between the monthly highest tidal level curve and the rainfall curve in Fig. 3-7, the greater the amount of sea water flows into the River Kemaman.

As increase in the outflow of rivers takes place a little later than a rainfall, and it will be unreasonable therefore to compare the rainfall curve with the tidal curve directly, but it is presumed that in April, when the least rainfall is experienced, the greatest influence of sea water is felt. The maximum tidal reach throughout the year and the longest period of time over which the chloride ion of the water is over 200ppm at No. 2 point is necessary.

The accurate value of this must be obtained from actual surveys taken throughout the year. But from the highest tidal level, rainfall, and chloride ion in September, the greatest influence of the sea-water is in April, we presumed, in this month, the maximum tidal reach take place at point No. 4 and the time which chloride ion will be over 200ppm at No. 2 point is about 6 hours.

*-1 Tide Table for Malaysia, Including Supplementary Tables and Information for the Year 1967.

*-2 Dungun Project: Table 3 - 6.

(b) The Highest and the Lowest Water Level.

Prerequisites for the intake site are availability of raw water of a suitable quality in a sufficient quantity and, at the same time, the ease with which intake tower can be constructed. In order to examine its possibility and to obtain numerical values for designing the intake tower, it is necessary to know the highest and the lowest water level at the proposed intake site.

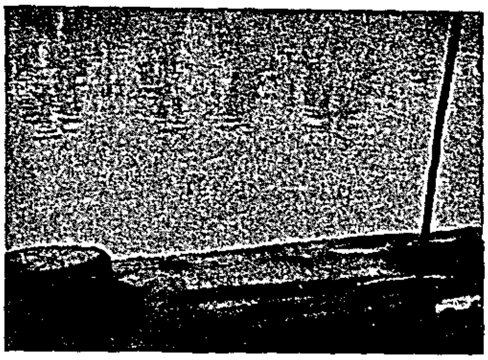
We surveyed the highest and the lowest water level at point No. 2. In respect to the highest water level, we were able to confirm from information given by the inhabitants near the site that the water level reached its flood stage in January, 1967, had been at its highest and that the level stood as shown in the photograph.

The Investigation of Maximum Flooded Level

As the result of the levelling, the level was found to have been 8'-8"*. We have taken for the highest level for designing, 9'-8", that is, 1 ft higher than that level.

As for the lowest level, we have taken for our design purpose -7'-2", that is, 1 ft lower than -6'-2", the measured value taken at 01:00 on September 16, 1967, which was the lowest tidal level in September. The lowest water level is desired to be confirmed in making a working design.

The Site of Intake Point



As the result of the above examination of ours, we have judged that point No. 2 satisfies the prerequisites for constructing the intake tower.

* The latitudes and the water levels are the result of the levelling based on B.M. of P.W.D.

(C) Determination of the Intake Point.

From what we have examined and weighed as above, we have come to the conclusion that as an intake point to get raw water from the River Kemaman, point No. 2, Kg. Ginjai, is the point most economically feasible.

The reasons are:

(1) Point No. 4 is presumed to be free from sea-water effects throughout the year, and is claimed to be the most suitable point in the Bolton report. But it is too far from the area to be served to be economically feasible.

(2) Point No. 3 is relatively less influenced by the sea-water-- so less influenced that even at the highest tidal level in September, 1967, chlorine ion contents detected amounted to only 45ppm. But its ground is so low that at the highest water level, the ground is submerged to the depth of about 4ft. In addition, some 600-yards road for construction purposes will have to be constructed to get to the point.

(3) Point No. 1 is very heavily influenced by the sea-water, so that in order to secure intake of water of under 200ppm chloride ion, at high tide intake operations will have to be suspended for about 6 hours (at the highest tide in September, 1967, about 6 hours). This will result in an unreasonable increase in the per-

hour quantity of water to be treated, hence it is highly uneconomical.

(4) Point No. 2 is situated about 4.5 miles nearer the area to be served than point No. 4, the site given in the Bolton report. This point is also under the influence of the sea-water, and during the highest tide in September, 1967, over 200ppm of chloride ion was detected for about 4 hours. Several days in a month when the highest tide takes place, therefore, depending in part on the flow of the river, chloride ion of more than the standard value is detected for 2 to 6 hours, making it necessary to suspend intake operations. However, when the flow of the river is larger, the hours which chloride ion is detected will be shortened. To meet this, starting and stopping the pump may easily be automated by means of the salinity selfdetecting device.

Taking into consideration the length of the inlet penstock and the hours of intake stoppage, point No. 2 is concluded to be the most economical. In addition, there exists a road for construction purposes.

Chapter 4. Water Supply Plant

4 - 1. Outline

In preparing the water supply plant plan, we attempted to devise a plant that would satisfy the conditions presented in the preceding chapters, and operation and management can easily be maintained at a low cost. The standard used was the standards of water facilities in Japan.

The foot and pound system of measurement was employed in this report and accompanying charts and tables, so as to be readily understood in Malaysia. We used the metric system for measuring designing, in the report the foot and system was substituted. The small difference produced by the conversion can be ignored.

The outline of the plant ; the original water taken from Kemaman river Kg. Binjai is sent under-pressure to the flash mixer, to be mixed with chemicals, then passes through the measuring weir, and is led to the flocculator. The top water separated from flocs in the sedimentation tank is dropped to the gravity filter to be purified completely by filtration. The filtration water is sterilized with chlorine, and sent by a pump to the reservoir in Bt. Jabo 4-1/2 miles away.

The water is also used for extinguishing fire.
This plant will be inspected at regular intervals by an inspecting board. Every vital process is simply operated by electricity or air pressure. The number of workers needed for the maintenance and operation will be 9 and they will work on three shifts.

The characteristics of this plant are : to stop the intake of water during high tide when chloride ion in the water goes beyond 200 ppm; to provide safe water regardless of whether or not the pump for stopping the intake is in operation.

The intake tower (excluding the pump), rising main, flush mixer, filter, supply mains and distribution mains of this plant are all adjusted to the needs of the expected 1995 expansion. The rest of the facilities are adjusted to the needs of the 1980 plan.

The construction of the water treatment plant will require at least 1.5 acres of land (207ft x 307ft). If, employees housing and recreation facilities are to be built, additional acreage will be needed.

4-2 Intake and Rising Mains

As a counter-measure against high tide, the possibility of constructing a reservoir at the point of intake to store the original water of the high tide, and thus operating the pump continually, has been considered. But, since its construction cost was estimated to be high and its operation rather complicated, it was decided not to employ this idea.

The intake pump is operated to stop or to start by the warning signals of the salimometer installed at the place of intake that controls the operation switch board of the treatment plant.

According to our investigation, there is a great difference between the maximum flood level and the lowest water level. As a countermeasure, a submergible pump will be used. The pump will be installed in the intake tower. Since the head for the intake pump is about 45 feet, it is not necessary to install a surge tank.

4-2-1 Planned Intake Amount

The expected amount of the water supply in 1980 will be 996,000 gallons per day, and 1,624,000 gallons per day in 1995. Adding the estimated treatment processing water of 6% of the supply water, it was estimated that the expected intake would be 1,056,000 gallons per day in 1980, and 1,722,000 gallons per day in 1995.

4-2-2. Intake Tower

Structure:	Reinforced concrete	
Size:	24'-6" (L) x 18'-6" (W) x 50'-0" (H)	
Screen		2
Structure:	Shape and band steel	
Size:	32" x 32"	
Size of the eyes:	25.4 (ASTM)	
Fittings to fit up a screen		2
Sluice gate:		2
Type:	Square sluice valve.	
Diameter:	32" x 32"	
Material:	Body ... F.C. Sheet .. B.C.	
Operating platform		2
Type:	External screw, gear driven.	
Material:	F.C.	
Intermediate shaft:		2
Material:	SUS-50	
Metal fittings for steady rest on intermediate shaft		2
Mechanical water gauge		1
Type:	Float driven with upper and lower limit alarm contact.	

4-2-3. Intake Pump

3 (one being for spare)

Type :	Submergible motor pump
Discharge :	506gal/min.
Diameter	6"
Total head :	49.3ft.
Revolution	2,900 r.p.m.
Motor	440V, 50c/s, 11KW.
Starting :	Star-Delta

1. Accessories to the pump:		
Submergible cable	3 phases, 4 wires	3
Support stand	18" x 18"	3
Air valve		3
Cable clip		3
2. Pumping pipe	6"	3
3. Discharge valve	6"	3
Type :	Sluice valve for water supply	
Material:	F C.	
4. Check valve	6"	3
Type :	Swing type.	
Material:	F.C.	

4-2-4. Cross bridge. 1

Structure :	Skeleton, truss structure.
Span :	60ft.
Width :	4 ft.

4-2-5. Driving Pipe.

Total length :	235ft. (12" Dia)
Material	Asbestos cement

4-3. Treatment Plant

The treatment plant consists of a flash mixer, chemical dosing equipment, flocculator, horizontal sedimentation basin, rapid sand filter, sterillizing apparatus, PH controller, filter water basin elevated tank for washing and necessary affiliated buildings. This will be constructed near the Intake Plant in Kg. Binjai.

Some characteristics of the plant are a horizontal sedimentation basin and a surface washing apparatus of the filter. Although the recent general tendency is to install sedimentation basins, it was decided in this case that the horizontal sedimentation basin which is more stable to operate should be used, considering that the apparatus has to be stopped temporally during high tide.

The most prevalent washing filter in Malaysia is the air scour system. However we decided to employ the surface washing system which is prevalent in U.S.A. and Japan because it is surface washing system is as follows ; Preceding a back wash, high pressured water is spurted out to the surface of the filter layer from many nozzles placed above the filter layer to break the mud layer, and wash it away effectively by causing sand grains to collide, inducing friction which also prevents the formation of mud balls. In Japan the scour system. was used, but recently it has been replaced by the surface wash system.

Our commission investigated the conditions of washing filter basins in Malaysia. In those cases in which the air scour system was employed, a mud layer was not broken and remained even after washing due to the inefficiency of the wash, and the surface of filtering layer was cracked, thus impeding the efficiency of the filter.

The water necessary for the chemical dosing equipment, sterlilizing apparatus, PH controller and for other miscellaneous purposes in the plant is taken from the supply main.

4-3-1. Planned Quantity of Filtered Water.

The planned quantity of filtrate is the same as that of the intake, that is 1,056,000 gal/day for 1980 and 1,722,000 gal/day for 1995.

4-3-2. Flash mixer

The flash mixer serves as a gauging well at the same time, and measures water flow at its outlet. Lime-milk is poured into the raw water which wells forth in the gauging well and after the mixture is fully mixed together with a mixer, alum is added to it just before the measuring weir.

Structure:	Reinforced concrete; inside, water-proofed and mortar finish.	
Size:	28'-6" (L) x 11'-0" (W) x 8'-6" (H)	
Capacity:	9,650 gal.	
Retention time:	6 minutes (in 1995)	
1. Mixer		1
Motor		1
Type:	Totally-enclosed-fan cooled 3-phase induction motor	
Output:	400V, 50c/s, 2.2KW.	
Rating:	Continuous.	
Reduction gear		1
Type:	Double-geared drive	
Reduction ratio:	1 : 15	
Impeller blade		2
Type:	3-blade	
Outside dia:	20"	
Revolution:	100rpm.	
Peripheral velocity:	8.7 ft/sec.	
Material:	SUS-27	
Propeller shaft		1

Material:	SUS-27	
2. Pipes and valves		a complete set
Inlet pipe:	12" CIP	
Inlet valve:	12"	1
Type:	Sluice valve	
Material:	F.C.	
Outlet pipe:	12" CIP	
Desludge pipe:	6" CIP	
Desludge valve:	6"	1
Type:	Sluice valve	
Material:	F.C.	
Overflow pipe:	6" CIP	
Inlet valve chamer:		1
Structure:	Reinforced concrete	
3. Measuring Weir		1
Type:	Rectangular.	
Material:	SUS-27	
Rectification wall		
Type:	Perforated pipe.	
Structure:	Reinforced concrete with built-in vinyl-chloride pipe.	
4. Ladder and Railings		a complete set
Structure:	Shape steel and steel pipe.	

4-3-3. Chemical Dosing Equipment.

This equipment consists of an alum dosing and a lime-milk dosing apparatus. Cakes of alum are dissolved in the solution tank and then the solution is poured in by gravity in an estimated quantity.

Slaked lime, after being sent to an solution tank in a fixed quantity via a dry quantitative distributor, is poured in by means of gravity. The result of the water examination shows that chemicals normally to be distributed are: alum ... about 20ppm and slaked lime ... about 10ppm.

form a curved surface so that it is hard for floc to deposit there.

Structure:	Reinforced concrete, water-proof and mortar finish inside.	
Size:	20'-6" (L) x 21'-6" (W) x 10'-6" (H)	
Capacity:	27,000 gal/per basin	
Retention time:	45 minutes	
Motor		2
Type:	Totally-enclosed-fan cooled, 3-phase induction motor. 440V, 50c/s, 2.2KW	
Rating:	Continuous	
Variable Speed Gear		2
Variable Range:	0.2 - 0.8	
Reducer		2
Reduction ratio:	1 : 187	
Paddle		4
Type:	Horizontal	
Outside dia	9ft.	
Revolution	1st stage: 2.4 - 6.4 r.p.m. 2nd stage: 1.87 - 5.0 r.p.m.	
Peripheral velocity:	1st stage: 0.75 - 3.0 ft/sec. 2nd stage: 0.585 - 2.34 ft/sec.	
Material:	Wood.	
Submergible Bearing		8
Material:	Body: F.C. Main parts: lignumvitae.	
Water Sealing Device		4
Type:	Gland sealing	
Flexible Coupling.		4
Type:	Flange type	
Material:	Body: F.C.	

	Main parts: hard rubber.	
Common bed		2
Veebelt & pulley		2
Sprocket wheel		8
Chain		4
Inlet pipe	10" CIP	
Inlet valve		2
Type:	Sluice valve	
Material:	F.C.	

4-3-5. Sedimentation Basin.

The sedimentation basin consists of two basins. The capacity is so designed that when both basins are put into operation, the retention time computed from the planned quantity of water will be 4 hours and 30 minutes, and when only one is put into operation due to scouring, it will be 2 hours and 15 minutes. The retention time designed in general is 3 hours. In order to heighten the sedimentation effect, rectification walls are to be built in three stages, and by collecting water at the outlet through pipes below the surface of the water instead of adopting the overflow system, thereby preventing the phenomenon of a sharp upward flow near the outlet.

The scouring of the sedimentation basin is accomplished by closing the valve in the intermediate wall and, after draining, by working the valve again and using a scouring hose concurrently.

Structure:	Reinforced concrete, water-proof and mortar finish.	
Size:	97'-6" (L) x 17'-6" (W) x 11'-6" (H)	
Capacity:	123,000 gal/per basin.	
Retention time:	270 minutes.	
Rectification wall		3
Type:	Multi-holes pipe	

Structure:	Reinforced concrete, with built-in vinyl chloride pipes.	
Outlet pipes:	8", 10", 14", CIP	
Outlet valves:	10"	4
Type:	Sluice valves	
Material:	F.C.	
Desludge pipes	6" CIP	
Desludge valve	6"	2
Type:	Sluice valve	
Material:	F.C.	
Connecting pipe	8" CIP	
Connecting valve	8"	
Type:	Sluice valve	
Material:	F.C.	
Head stock		2
Type:	External-screw type, hand operate	
Material:	F.C.	
Desludge valve box		2
Type:	Screw type	
Material:	F.C.	

4-3-6. Filter

The filter consists of three basins, one of which is a spare.

Low collection mechanism is of a perforated pipe system, using vinyl chloride pipes.

The flow at the outlet of the filter is controlled by the air quantitative flow adjuster. The scouring of the filter starts with the alarm of the loss of head gauge and is accomplished by operating the handle of the operation stand.

Structure:	Reinforced concrete, inside, water-proof and mortar finish.
Size:	21'-0" (L) x 17'-0" (W) x 12'-0" (H) (each)
Filter area:	320ft^2/per basin.
Rate of Filtration:	100 gal/ft^2/hr.
Rate of back washing:	650 gal/ft^2/hr.
Rate of surface washing:	260 gal/ft^2/hr.
Expansion ratio of sand at the time of reverse washing:	30%

Regeneration process

Surface Scouring:	3 minutes
Reverse flow scouring:	6 minutes
Rest:	5 minutes
Waste water(to be thrown away):	3 minutes.

1. Surface washing system

Type:	Fixed
Material:	Nozzle: BC , pipe : steel

2. Under drain system

Type:	Perforated 2" PVC

3. Pipes & Valves in piping gallery.

Pipes used are of cast iron and valves are pneumatic valves.

Inlet pipe:	10", 14", CIP	
Inlet valve:	10"	3

Type:	Sluice valve	
Material:	F.C.	
Outlet pipe:	10", 12", CIP	
Outlet valve:	10"	3
Type:	Sluice valve	
.Material:	F.C.	
Wash water inlet pipe:	12" CIP	
Wash water inlet valve:	12"	3
Type:	Sluice valve	
Material:	F.C.	
Surface wash inlet pipe:	10" CIP	
Surface wash inlet valve:	10"	3
Type:	Sluice valve	
Material:	F.C.	
Drain pipe	16" CIP	
Drain valve	16"	3
Type:	Flat	
Material:	F.C.	
Rinsing pipe:	8" CIP	
Rinsing valve:	8"	3
Type:	Sluice valve	
Material:	F.C.	
Bypass pipe:	10" CIP	
Bypass valve:	10"	3
Type:	Sluice valve for hand operate	
Material:	F.C.	

4. Trough

Structure:	Steel plate, coated with anticorrosive paint.
Size:	21'-0" (L) x 2'-0" (W) x 1'-10" (H)
Gradient:	2/100.

5. Filter media.

Filter sand:	$640ft^3$/per basin x 3
Grain diameter:	0.018 in.---0.028 in.
Uniformity coefficient:	1.7 and below.
Depth:	2'-0"
Filter gravel:	$534ft^3$/per basin x 3
Grain diameter:	0.08 in. -1 in.
Depth:	1'-8"

6. Wash water piping

From the elevated wash tank up to the inlet to the pipe gallery, cast iron pipes of 12" dia are used and are fitted with a venturi type flow indicator.

Flow indicator		1
Type:	Venturi	
	12" Dia	
Venturi chamber		1
Structure:	Reinforced concrete.	
Size:	10' -0" (L) x 7'-6" (W) x 5'-8" (H).	

4-3-7. Sterilization Apparatus.

Sterilization of filtrate is done by distributing chlorine water at the inlet of the filtrate tank by a vacuum type chlorinator for water supply use.

The chlorination ratio is usually determined so as to make isolated residual chlorine 0.1ppm. at the end of the supply pipe.

1. Chlorinator 2 (including one spare)

Type:	Vacuum	
Capacity:	Maximum 4.4lb/hr.	

2. Chlorine bombe — 2

Capacity:	110lbs.	

3. Accessories.

4-valve manifold	2
Auxiliary valve	11
Pressure gauge with alarm contact	1
Platform weighing machine	1
Copper pipes	
Vinyl chloride pipes	
Pipe and valves.	

4-3-8. PH Control Apparatus.

In order to keep PH in the supply water, a PH adjusting apparatus by means of the dosing of slaked lime is provided and a fixed quantity of lime emulsion is distributed at the inlet to the filtered water tank. This apparatus can serve as a spare for the chemicals distribution apparatus.

1. Dry feeder — 1

Type:	Automatic injector of the fixed quantity system.
Capacity:	$0.141ft^3/hr - 1.06ft^3/hr$.
Motor:	440V, 50c/s, 0.2KW

2. Lime milk tank. — 1

Structure:	Hoop
Size:	3'-4"(L) x 3'-4"(W) x 2'-6" (H).
Capacity:	80 gal.

3. Attached pipe and valves.

Dilution pipe:	1" SGP	
Dilution valve:	1" stop valve B.C.	1
Lime milk dosing pipe:	1" rubber hose	
Outlet valve:	1" ball valve F.C.	1
Blow pipe :	1" PVC.	
Blow valve:	1" ball tap valve F.C.	1
Stand for a tank and hopper		
Structure	Shape steel and steel plate.	

4-3-9. Filtrate Tank

The filtrate tank is designed to have a capacity to meet the requirement in 1995.

Structure:	Reinforced concrete, water-proofed and mortar finished.	
Size:	39'-0" (L) x 40'-0" (W) x 12'-0" (H).	
Capacity:	89,500 gal	
Desludge pipe:	6" CIP	
Desludge valve:	6"	1
Type:	Sluice valve	
Material:	F.C.	
Desludge valve case		1
Type:	Screw type	
Material:	F.C.	

4-3-10. Elevated Tank for Washing 1

To facilitate the scouring of the filter, an elevated tank is provided in which wash water is to be stored.

Wash water is obtained from the delivery mains just before its flow meter with the pressure reduced.

The elevated water tank is to be a prefabricated panel tank.

Structure:	Prefabricated panel tank.	
Material:	Steel plate.	
Coating painting:	Inside: Sand-blast metallikon Outside: Anti-corrosive, and silver paint finish.	
Size:	26'-3" (L) x 22'-11-9/16" (W) x 9'-10-1/8" (H)	
Capacity:	29, 700 gal.	
Total height:	37'-6-1/8"	
Stand		
Structure:	Steel pipe, steel plate & section steel.	
Lightning conductor		1
Air escape pipe.		
Dia:	4" SGP	
Overflow pipe:		
Dia:	8" CIP	
Drain pipe		
Dia	6" CIP	
Drain valve		1
Type:	Sluice valve	
Dia:	6"	
Material:	F.C.	
Inlet pipe:	4" CIP	
Inlet valve		2
Type:	Sluice valve	
Dia:	4"	
Material:	F.C.	
Outlet valve.		1
Type:	Sluice valve	
Dia:	12"	

Material:	F.C.	
Pressure-reducing valve		1
Dia:	4"	
Material:	F.C.	

4-3-11. Accessory Buildings

The main management building is to contain rooms for operations which is necessary for the operation, maintenance and management of the water treatment plant, an electric, a pump, piping, a chemical distribution, a chemical store, a sterilization, a water analysis laboratory, an office, and a shower.

Finishing of the Room

Room	Panel	Wall	Ceilling	Floor
Central Room	Vinyl paint	Plaster	Plaster	Linoleum
Electrical Room	Plaster	"	Bare	"
Pump Room	Vinyl paint	"	"	Terazzo-tile
Piping Gallery	Bare	Bare	"	Bare
Chemical Room	Acid-Proof Mortar	Acid-Proof Mortar	Acid-Proof Mortar	Acid-Proof Mortar
Chemicals Store	Bare	Bare	Bare	Bare
Chloríne Room	Acid-Proof Mortar	Acid-Proof Mortar	Acid-Proof Mortar	Acid-Proof Mortar
Laboratory	Mosaic Tile	Plaster	Acoustic Board	Mosaic Tile
Office	Plaster	"	"	Linoleum
Lavatory	Mosaic Tile	"	Bare	Mosaic Tile
Night Duty Room	Plaster	"	Acoustic Board	Linoleum
Kettle Room	Mosaic Tile	Mosaic Tile	Mosaic Plaster	Mosaic Tile
Passdge	Plaster	Plaster	Acoustic Board	Clinder Tile

4-3-12. Apparatuses (including reagent) for Water-Quality Analysis

Provided that no reagent is in principle prepared, examination apparatuses necessary to carry out the following items of analysis are to be provided.

The items of analysis are as follows:

- Turbidity
- PH
- Conductivity
- Color
- Water temperature
- Alkalinity
- Choride ion
- Residual chlorine
- Coagulation test

Apparatuses necessary for water-quality analysis are as follows;

Testing table		2
Size :	25ft x 40ft.	
Sink		1
Size:	20ft x 25ft.	
Material:	SUS-27	
Rack for reagent		1
Size:	80ft x 10ft. x 27ft.	
Jar-Tester(six-throw type)		1
Thermometer	0-50°	2
Apparatus for measuring turbidity		1
Apparatus for measuring color		1
PH meter		1
Conductivity meter		1
Testing apparatus for chloride ion and alkalinity.		1
Residual chlorine tester		

4-3-13. Miscellaneous Construction Work

Catch basin

Structure:	Reinforced concrete.

Drain pipe

Type:	Hume concrete pipe.

Gutter

Structure:	Concrete, 'U' shaped

Gate, fence and Road

4-4. Filtrate Pump and Supply Main

These facilities consist of filtrate pumps, surge tanks and supply main.

Estimated supply by pump to meet the demand in 1980 is 1,056,000 gal/day and estimated supply by supply main to meet the demand in 1995 is 1,722,000 gal/day.

The filtrate pumps are of high pressure with a total head of 230 feet and because of the great distance in supply, surge tanks will be provided. Supply main will be laid along the shoulder of the road by utilizing the existing, almost flat, road which connects the water treatment plant and the reservoirs. Supply main will be of asbestos cement pipe and steel pipe will be used for pipes along bridge. Air relief valves and desludge valves will be provided where necessary. Further, in order to supply water to the villages along the road on which the supply main will be laid, the transportation tank will branch off for this purpose. For this reason, the supply main will be connected to the bottom of the reservoir.

4-4-1. Filtrate Pump

3 units
(one for stand-by)

Type:	Horizontal Multi-Stage Turbine	
Capacity:	594 gal/min.	
Total head	230 ft.	
Motor	3 Units	
Type	Totally enclosed fan cooled three phase induction motor with a spare motor	
Revolution	1,500 r.p.m.	
	440V, 50c/s, 55KW	
Accessories		
Suction pipe	6" CIP	
Foot valve	6"	3
Material	F.C.	
Delivery pipe	10" CIP	
Delivery valve	10"	3
Type:	Sluice valve	
Material	F.C.	
Check valve	10"	3
Type:	Swing	
Material:	F.C.	

4-4-2. Surge Tank 1 Unit

Construction:	Steel plate	
Type:	Vertical cylinderical type	
Size:	5'-9" (D) x 17'-8" (H)	
Collateral Equipment		
Concrete foundation		
Ladder		1
Level gauge		2
Supply main	16" SGP	
Supply valve		1
Type:	Sluice valve	

Diameter :	16"	
Material:	F.C.	
Check valve		
Type:	Swing type	
Diameter:	16"	
Material:	F.C.	
Filling pipe	4" SGP	
Filling intake valve:		1
Type:	Sluice valve	
Diamter :	4"	
Material:	F.C.	
Overflow pipe	4" SGP	
Escape valve		1
Diameter	4"	
Air relief valve	1" SGP	
Safety valve		1
Diameter	1"	

4-4-3. Supply Main A complete set

Total length	23,150 feet (16" in diameter)	
Desludge valve	6"	4
Type:	Sluice valve	
Material:	F.C.	
Desludge valve chamber		4
Type:	Screw	
Material	F.C.	
Air relief valve	3"	3
Type:	Double (opening) air relief valve	
Material :	F.C.	
Air relief valve room (chamber)		3
Construction	Reinforced concrete	

1. Alum Dosing Apparatus:

Solution tank.		2(including one spare)
Structure:	Steel plate (with internal rubber lining	
Size:	4'-10" (L) x 4'-0" (W) x 3'-4" (H)	
Capacity:	300 gal.	
Agitator		2(including one spare)
Type:	Vertical gear-drive	
Revolution:	290 r.p.m.	
Material:	Where the solution comes in contact with: SUS-32	
Motor:	440V, 50c/s, 0.75KW	
Steady level tank		1
Material:	SUS-32	
Dilution pipe:	2" SGP	
	1" SGP	
Dilution valve	2" stop valve B.C.	1
	1" stop valve B.C.	2
Solution pipe:	1/2" PVC	
Solution valve	1" stop valve SUS-27	2
Blow pipe	1" PVC	
Blow valve	1" ball valve SUS-27	2
Float valve	1" PVC	1
Tank stand		1
Structure:	Shape steel & steel plate	

2. Lime dosing Apparatus

Dry Feeder	1

Capacity:	$0.141\ ft^3/hr.$ ---$1.06\ ft^3/hr.$	
Motor:	440V., 50c/s, 0.2KW.	
Lime milk tank		1
Structure:	Steel plate	
Size:	3'-4" (L) x 3'-4" (W) x 2'-6" (H)	
Capacity:	80 gal.	
Dilution pipe:	1" SGP	
Dilution valve	1" stop valve B.C.	1
Lime milk dosing pipe	1" rubber hose	
Outlet valve	1" ball tap valve F.C.	1
Blow pipe	1" PVC	
Blow valve	1" ball valve F.C.	1
Stand for a Tank and Hopper		1
Structure:	Shape steel & steel plate	

3. Chemicals transportation facilities

Hoist		1
Type:	Mini-hoist with electric trolley.	
Capacity:	550 lb x 20 ft.	
Motor:	For running: 0.05KW.	
	For lifting: 0.5KW.	

4-3-4. Flocculator

The flocculator consists of two basins. The capacity is so designed that when the two basins are both put into operation, the retention time computed from the planned quantity of filtrate will be 56 minutes, and when only one of them is put into operation on account of scouring, it will be 28 minutes. The retention time designed in general is 30 minutes.

Slow stirring is a mechanical way of stirring by the use of a flat 2-stage flocculator. The bottom of the floc formation basin is made to

4-5. Reservoir and Distribution Pipeline.

This facility consists of a reservoir and distribution mains. The reservoir, considering ease of construction and the land area, will be of square reinforced concrete and will be constructed at Bt Jabor, 125 feet above sea level. Its capacity is 0.54 MG which is equivalent to a little over the estimated quantity of supply for a half day supply in 1980.

Asbestos cement pipe will be used for the distribution main and the size of the main was determined in accordance with the planned hourly maximum water quantity which will be demanded in 1995, with the use of electronic computers and utilizing the HC (Hardy Cross) method so as to bring the pressure at the end of supply to over 21 lb/in^2 (1.5 kg/cm^2). A booster pump will be installed on the main immediately before crossing the Kemaman river. As to the area to be served to meet the demand in 1980, densely populated areas have been selected from the standpoint of economic effectiveness.

Steel pipes will be used for bridge piping and for the portion of the main crossing the river. Air relief valves and drain valves will be installed where necessary and fire hydrants will be provided appropriately at the rate of 4 for each mile.

4-5-1. Distribution Plan

The Distribution plan is shown on Table 4-1.

Now, the planned hourly maximum supply quantity was obtained from the sum by multiplying by 1.7, the ratio of the daily average supply quantity of Trengganu water on August 26, 1967, which is shown on Chart I.

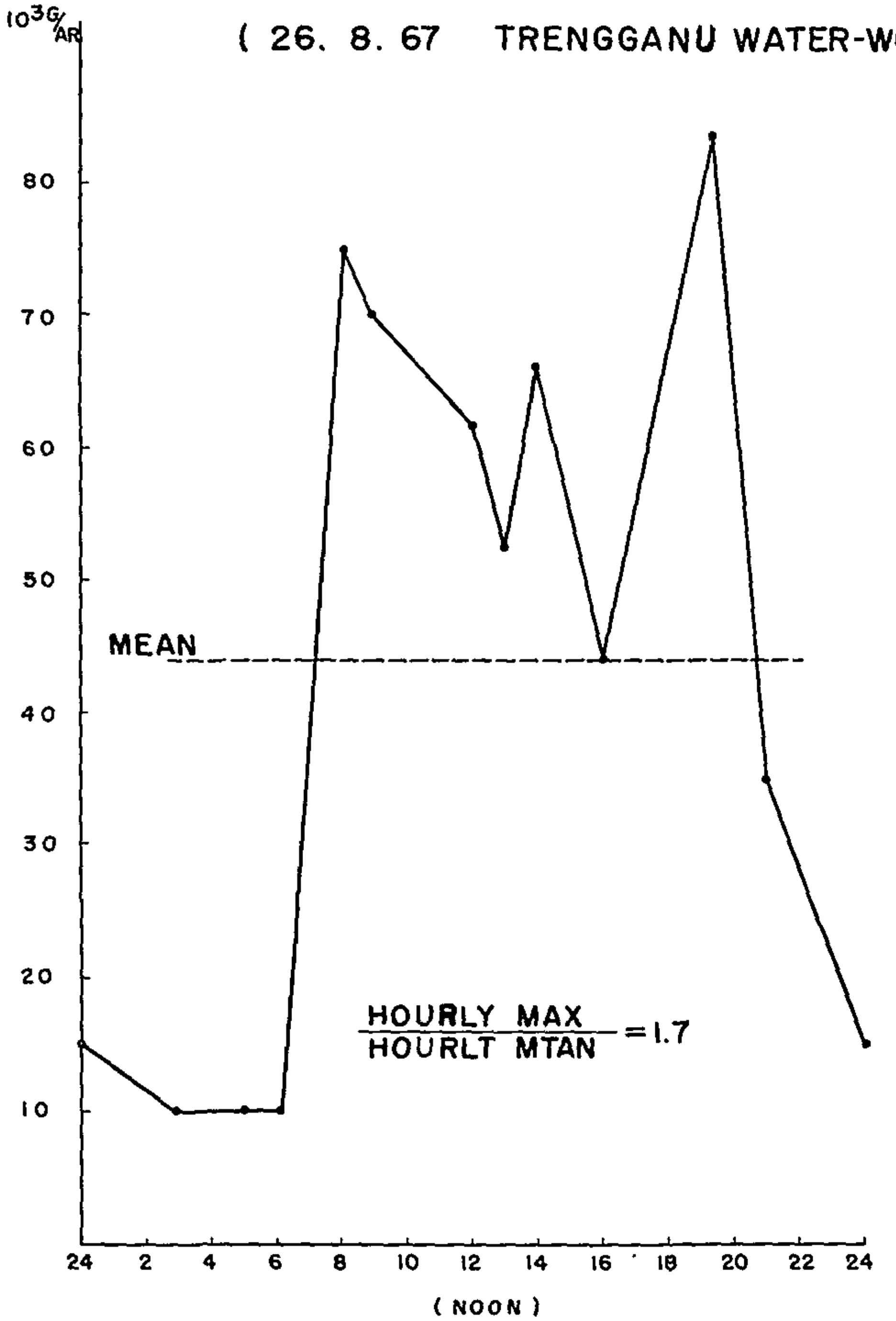
The Hill Proposed to Reservoir Site

4-5-1. Water Distribution Plan.

Planned Year	Population Served	Gallons per Head per day Consumption	Planned Consumption (gal/day)	Maximum Capacity of Pipeline (gal/day)
1980	33, 200	30	996, 000	1, 693, 000
1995	46, 400	35	1, 624, 000	2, 761, 000

FIG. 4-1 HOURLY WATER CONSUMPTION

(26. 8. 67 TRENGGANU WATER-WORK)



4-5-2. Reservoir 1

Structure	Reinforced concrete water-proof mortar finish inside.	
Size:	34'-0" (L) x 63'-0" (W) x 21'-5" (H)	
Capacity:	0.54 MG	

1. Pipe and Valves

Inlet pipe	16" CIP	
Inlet valve	16"	2
Type:	Sluice valve	
Material	F.C.	
Outlet pipe	12" CIP	
Outlet valve	12"	2
Type:	Sluice valve	
Material	F.C.	
Blow off pipe	10" CIP	
Blow off valve	10"	2
Type:	Sluice valve	
Material:	F.C.	
Overflow pipe	18" CIP	
Conjunction pipe	8" CIP	
Conjunction valve	8"	
Type:	Sluice valve	
Material :	F.C.	
Valve stand		
Material	F.C.	

2. Measuring Instruments

Flow totalizing recorder (mechanical driven)		1 Unit
Venturi tube	12" dia	
Underground Venturi - chamber		
Construction	Reinforced concrete	
Size:	10'-0" (L) x 7'-6" (W) x 12'-0" (H)	
By-pass pipe	12" CIP	
By-pass valve	12"	3
Type	Sluice valve	
Material	F.C.	

4-5-3. Booster Pump 2

Type	Submergible pump	
Capacity	132 gal/min.	
Diameter	2-1/2"	
Total head	180 ft.	
Revolution	2,900 r.p.m.	
Motor	440V 50c/s 11KW	
Pump attachments		
Submergible cable (3 phase 4 line)		
Control valve	2-1/2"	4
Air relief valve		2
Check valve	2-1/2"	2
Suction cover		2
Pump room		
Structure	Reinforced concrete	
Size	10'-0"(L) x 10'-0"(W) x 9'-0" (H)	

4-5-4: Distribution Main

Title	Diameter (inch)	Total length(feet)	Remarks
Main	12	4,400	Asbestos cement pipe
"	10	2,900	"
"	8	5,400	"
"	6	13,000	"
"	5	7,500	"
"	4	16,800	"
"	3	10,700	"
Total		60,700	
Sub-main	3	5,400	Asbestos cement pipe
"	2	19,300	Hard chloride vinyl pipe.
Total		24,700	
Grand Total		85,400	

Submergible piping		one place	
Drain valve			
	Type	Sluice valve	
		3"	3
		2"	1
	Material	F.C.	
Drain chamber			4
	Type	Screw	
	Material	F.C.	
Air relief valve		1"	2
	Type:	Single	
Air relief valve chamber			2
	Structure	Reinforced concrete with a cast iron cover	
	Size	1'-9-1/2" (L) x 1'-1/2" (W) x 2'-8" (H)	

4-5-5. Hydrant

Hydrant		37
Type	Single under ground type	
Diameter	3"	
Hydrant chamber		37
Structure	Reinforced concrete with a cast iron cover.	
Size	1'-9-1/2"(L) x 1'-1-1/2"(W) x 3'-8"(H)	

4-6. Electrical Equipment and Instruments

Our commission and E.P.U. agreed that the power necessary for the water supply plant construction would be fully provided by the N.E.B. destrict power station.

Accordingly, it will be employed as the first choice and an alternate suggestion will be presented in 4-9.

The maximum power demand of the Plant is 212 KVA under the 1980 Plan, and 292 KVA under the 1995 Plan.

From the economic point of view as well as efficiency the water supply plant is to receive the power of 3,000V, and to regulate voltage according to need. The N.E.B. power station will have to install a booster to transform 440V to 3,000V for the distribution.

Power incoming apparatus will be installed in the treatment plant to transform 3,000V to 440V as needed for motors, lighting and instruments calculating apparatuses and controlling apparatuses.

4-6-1. Electrical Equipment

Electrical equipment is divided into two sections, i.e., within the water treatment plant and the booster pump room. Each of the motors in the plant will be operated from the control panel in the operations room. However, motors for chemical dosing equipment, flash mixer, flocculator and for the filtrate pumps will be operated in the field.

Electrical equipment in the water treatment plant is as follows:

1. High tention power incoming facilities
2. Incoming Panel 1

Location:	In a separate building in the treatment plant premises
Attachments:	Disconnecting switch Oil circuit breaker Protecting devices from earthing, overcurrent, under-voltage. Voltmeter Ammeter Internal wirings

3. Transformer Panel

Location:	Same as in the case of incoming panel	
Attachments	High tention cut-out switch	
	Transformer (oil-immersed and self-cooled)	
	3,300/440V, 300 KVA	
	3 phàse 4 line	
	Disconnecting switch	
	static condenser with built-in discharge coil.	
	Internal wirings	

4. *Power distribution board* 1

Location:	Electrical room	
Attachments	Main switch	
	Transformer 240/100V 1 ϕ ' KVA	
	Voltmeter	
	Ammeter	
	Frequency meter	
	Internal wirings	

5. Main switch board 1

Location	Electrical room	
Attachments	Circuit breaker	
	Branch circuit breaker	
	Internal wirings	

6. Panel for incoming power at intake tower 1

Location	Intake tower pump room	
Attachments	Main circuit breaker	
	Voltmeter	
	Ammeter	
	Small transformer 240/100V 500 KVA 1 ϕ	
	Power source box for instruments	
	Terminal box for connection of instrument	
	Internal wirings	

7.	Motor panel for intake tower		1
	Location	Intake tower pump room	
	Attachment	Circuit breaker	
		Starters	
		Operation switch	
		Signal lights	
		Operation control circuit	
		Current converter for ammeter	
		Internal wirings	
8.	Motor panel for chemical room		1
	Location	Chemical room	
	Attachment	Circuit breaker	
		Starter	
		Operation switch	
		Signal lights	
		Operation control circuit	
		Internal wirings	
9.	Motor panel for pump room		
	Location	Pump room	
	Attachment	Starting rheostat	
		Starter controller	
		Pilot motor for starting rheostat	
		Operation switch	
		Signal light	
		Operation control circuit	
		Internal wirings	
10.	Operation stand for outdoor use		1
11.	Lighting equipment		
	Power distributing board for lighting		1
	Location	Electrical room	
	Attachments	Circuit breakers	
		Internal wirings.	
	Indoor lightings		
	Type:	Fluorescent lamp	

Outdoor lightings

Type:	Incandescent lamp with shade for filters

Mercury lamps

12. Cabling and wiring materials

Electrical equipment in the booster pump room are as follows:

1. Incoming panel

Location:	Booster pump room
Attachments	Air circuit breaker
	Cut-off device for the above (earthing overcurrent, undervoltage)
	Voltmeter
	Ammeter
	Internal wirings

2. Electric motor panel 1

Location	Same as incoming panel
Attachment	Circuit breaker
	Ammeter
	Starter
	Operation switch
	Operation control circuit
	Internal wirings

3. Lighting equipment

Power distributing board for lighting

Location	Booster pump
Attachments	Circuit breaker
	Internal wirings

Indoor lightings

Type	Fluorescent lamp

4-6-2. Instrumentation

Items measured with the instrument are as follows.

1) Salinity at the intake point
2) The water level of the filtrate tank
3) PH in the filtrate tank
4) The water level of the reservoir
5) Water level of elevated tank
6) The loss of each head of filter
7) The rate of flow in each filter outlet

Of the equipment and instruments for the above items, those for items 1) through 5) will be installed on the instrument panel in the control room and those for items 6) and 7) will be installed on each filter control panel in the control room.

Instrumentation will consist of the following equipment and instuments.

1. Instrument panel		1
Location	Control room	
Attachments	Ammeter for raw water pump	
	Ammeter for filtrate pump	
	Control switch for intake pump	
	Control switch for air compressor	
	Motor operation indicating light	
	Alarm indicating light	
	Air failure	
	Brine intermixed	
	Filtrate tank water level high and low	
	Reservoir water level high and low	

	Elevated tank water level high and low	
	Filter head loss increase	
	Abnormal PH in filtered water	
	Drop of chlorine pressure	
	Switches for lamp test and buzzer stop of the above	
	Salinity (Brine) indicator with alarm	
	Level indicator with alarm for filtrate	
	PH indicator with alarm for filtrate	
	Level indicator with alarm for elevated tank	
	Level indicator with alarm for reservoir	
	Warning setting device for the above	
	Power units for instruments	
	Materials for internal wiring and terminal board	
2. Filter control panel		3
Location	Control room	
Attachments	4-way pilot valve	
	Loss of head indicator with alarm	
	Filtered flow indicator	
	Rate of flow indicator for filter outlet	
	Internal wirings	
3. Air compressor for control		2 units
Location	Piping gallery	
Accessories	Air receiver	
	Oil separator	
	Pressure reducing valve	

4. Instrument

Salinity (brine) indicator with alarm for raw water		1

This meter detects the increase of chloride in raw water at high tide and transmits a warning when the chloride exceeds the setting of the warning meter.

Scale	0 - 300ppm	
Type	Electromagnetic induction system Submergible cell and transmitter	
Level indicator with alarm for filtrate tank		1
Scale	0 - 15 feet	
Type	Float driven and electrical transmission with upper and lower limit alarm contact	
PH indicator with alarm for filtrate		1

This meter detects and indicates PH in filtered water and transmits a warning in case of abnormality.

Scale	0 - 14 PH	
Type:	Submergible glass electrode	
Level indicator with alarm for reservoir		1
Indication of water level of reservoir and transmission of warning		
Scale	0 - 20 feet	
Type	Mechanical pressure converter	
Alarm for elevated tank		1
Transmission of warning on water level of elevated tanks		
Scale	0 - 15 feet	
Type	Electrode system	
Filtration basin lost head indicator warning meter		3
Loss of head indicator with alarm for each filter		

Scale	0 - 10 feet
Type	Differential pressure conversion electrical transmission

Rate of flow indicator 3

Indication of outlet flow for each filtration basin and adjustment of flow constantly

Scale	0 - 30,000 gal/hr.
Type	Venturi tube differential pressure conversion electrical transmission

For setting the flow, the differential pressure at the time of flow in the Venturi tube is measured and then compared with the valve set by the control valve in the area and controls the flow by operating a butterfly valve at an unbalanced power.

5. Materials for instrumentation wiring and piping

4-7. Operation and Management

The plant is designed so that operation, and management can be easily maintained. Since it greatly resembles the already existing water supply plants in Malaysia, workers can be trained easily in any near-by plant where there are spares in reserve for the intake pump, chemical dosing equipment, sterilizing apparatus, and air compressor to secure full-time operation. The operation diary necessary for the maintenance of operation, and management must be kept daily.

4-7-1. Water Quality

In order to provide water that satisfies the W.H.O. standards, an inspection of chloride ion, turbidity, colour, PH values residual chlorine and alkalinity, must be performed and recorded daily. Accordingly, these test apparatuses are necessary. The insepection of the coliform groups and bacteria accounts should be performed at regular intervals by an adequate authority. The inspection shows the condition and quality of the water ; and if the water has any inadequacies in service, a necessary measure must be taken. The dosing amount of coagulant and coagulant aid must be adjusted to the results of jar tests. The amount of chlorine dosing should be determined after a chlorine-demand test.

The amount of chlorine used for sterilization should be determined after a chlorine-demand test. And clarity bowls should be installed to show the raw water, effluent from sedimentation basin and filtered water.

4-7-2. Apparatuses

All the apparatuses operate on a full time basis with the exception of the filter and a apparatus that stops temporally during high tide. The sludge of the sedimentation basin will be disposed of by stopping the operation at regular intervals. The filter will be washed according to the following table : 4-2.

Table 4-2

	Time (min.)	Rate of filtration (gal. ft^2/Hr)	Amount of Water (gal.)
Surface wash	3	260	4, 160
Back wash	6	650	20, 800
Intermission	5	--	--
Rinsing	3	100	1, 600
Filteration	-	100	--

The operation of the plant usually requires 210 lbs/day of alum, 210 lbs/day of slaked lime, and 32 lbs/day of chlorine.

Alum is taken from storage every other day, and is stored in the form of solution in the solution tank. Slaked lime will also be fed into the chemical feeder every other day. A thirty day supply of the chemicals should be kept in reserve. And operators should wear chlorine gas masks and gloves.

The treatment plant site and the place of intake should be kept clean at all times.

4-7-3. Electrical Concerns

If changes of more than ± 10% are induced in the provided voltage and cycle, the low voltage relay and overcurrent relay will react automatically to stop the operation of the plant in order to protect it. For this reason, the voltage regulation of the provided power must be kept under ± 10%.

Since the provided power voltage is 3, 000V, a qualified engineer should be employed to manage the plant.

4-8. Expansion Plan

As mentioned previously, these facilities are of the size which will meet the demand of 1980, however there will be a need for expansion in 1995. In anticipation of this expansion, necessary space has been provided in all pump rooms for additional pump installation and sufficient land area necessary for expansion has been also provided for the floccula- tion basin, and filtration basin.reservoir.

As for the electrical facilities, equipment for in coming power with an electrical capacity to meet the expansion have been provided and the connecting cables have been equipped with the number of coils neces- sary after expansion of the facilities. Also, a space has been provided in the panel and all that will be required is to install internal equipment and instruments. (However, one new filter control panel will be installed).

4-9. Power Plant (alternative suggestion)

It is considered that possession of their own generator is more advantageous than the method of power supply which was adopted in the original plan in sections 4-6 and 4-7 as the item finalized by Malaysian authorities and the survey team, in respect to economy and stability even when there is extra work involved in respect to administration of the facility, this item is recommended as an alternate plan.

This facility consists of diesel engine, generator, fuel system, fuel tank and auxiliary equipment.

The capacity of the generator has been set at 205 KVA to meet the demand of 1980 and the capacity of 300 KVA will be considered in the future plan to meet the demand of 1995. Generator voltage and the frequency will be 440V and 50 cycle respectively in compliance with the standard of Malaysia. Generated power will be supplied directly to the panel for incoming power at the treatment plant.

To install the generators, an additional 160 square yards of land area will be required above the area projected in the original plan. As power plant construction cost, the sum of M$ 362,000 is required.

4-9-1. Diesel engine generator

1. Diesel engine

Type:	Vertical, 4 cycle diesel engine
Number of cylinders:	6
Continuous rating output:	150 PS
Revolution:	1,500 rpm
Combustion system:	Pre-combustion chamber system
Lubrication system:	Forced lubrication by gear pump
Cooling:	Forced water circulating cooling system
Starting method:	Self-starter
Fuel type and fuel consumption:	Heavy oil, 0.44 lb/ps/hr.

2. Generator

Type:	Open protective type
Output:	125 KVA
Phase:	3
Voltage:	440V
Frequency:	50 c/s
Power-factor:	80% lag
Number of poles:	4
Revolution:	1,500 r.p.m.
Excitation:	Self-excitation by a static exciter

3. Generator board

Type:	Enclosed self-support system
Attachments	Voltmeter
	Ammeter
	Power-factor meter
	Wattmeter
	Circuit breaker
	Protective relay

4. Period checking board

Type:	Blacket panel
Attachment:	Voltmeter
	Frequency meter
	Checker

5. Accessories

Exhaust silencer

Exhaust flexible pipe

Fuel tank (100 gal)

Fuel flexible pipe

Fuel stand

Battery DC 24V, 150 AH

Silicone rectifier for charging the above

Anti-shock rubber

Standard tools

6. Spare parts (for 2 year use)

Nozzle

Spare combustion chamber packing

Piston ring

Exhaust valve with spring

Plunger spring

Rubber packing for cooling water

Discharge valve spring for use on a fuel pump

Volt pin for rods

Fuel pump plunger

Discharge valve for a fuel pump

High pressure fuel pipe.

Governor spring

7. Wiring for power

4-9-2. Auxiliary equipment

1. Fuel storage tank

Type:	Cylindrical horizontal steel plate
Capacity:	3,300 gal (for 10 day's use)
Accessories:	Oil gauge
	Piping and valves for receiving heavy oil
	Air vent pipe
	Fuel drainage valve

2. Exhaust duct

3. Chain block

Capacity:	3 tons
Accessories	I-beam

4. Oil feeding piping and cooling water piping

4-9-3. Generator House a complete set

Acreage	145 square yards

Chapter 5. Construction Work

As the period of survey including Dungun City was 40 days and the following report on construction work is limited to essential details only, items related to the construction work must be studied and prepared as soon as possible.

5-1. Intake Tower

In designing the facilities for the source of water, the maximum and the minimum water level were determined based on the data from the field survey. As described in the drawings, the maximum water level was determined one foot higher than the level of flood in January 1967 which is believed to have been the worst flood in the past five years according to local residents, and the minimum water level was set at one foot lower than the level measured September 16, 1967 which was the lowest level during the survey period. The intake tower has been designed with the maximum and the minimum water level determined in the manner mentioned above. Therefore, these water levels should also be reviewed in the future and be given the utmost attention at the time of construction. Moreover, as the well sinking method is being adopted for the construction of intake tower, excavation and sinking the well is to be accomplished by building the well wall while preventing the cave in of the surrounding earth. However, since there is a possibility of unexpected stress caused by an inclined well tube due to unbalanced placing of well tube, full consideration should be given to the design of the well, to the alignment of reinforced bars and the thickness of the wall of the well, and adequate supervision of construction is required in order to prevent an uneven load placed while sinking the well or excess sinking of the well in using the hydro digging machine.

Since the location of the intake tower was determined by judging the condition of the present river bottom and the degree of sinking was determined on the assumption that the results of boring (Drawing5-1), which the survey team conducted at the river bottom, would be obtained at the same depth , it is necessary to obtain an accurate depth of surrounding ground by boring at this location before sinking the well. In addition, it is recommended that the frame work of the rod (including the curb shoe) of well tube be made of steel sheeting and its entire length be maintained at water level and the well tube be transported by floating for installation of the first rod.

5-2. Water Treatment Plant

Since a site with adequate land resistance was secured for the foundation of concrete structures for the sedimentation basin and filtration basins, there is no need for driving in piles or for other special foundation works.

Since the site of the water treatment plant is located at a point of 1.2km from the highway and the width of the existing roads is narrow, there is need for expansion of the existing roads for transporting construction materials and equipment and also for maintenance and administration of the equipment in the future.

5-3. Distribution Main

The distribution main for cross-laying for the crossing of the Kemaman river from Chukai Jown Board, will be a steel pipe from the standpoint of maintenance and administration of the main. Parallel laying of these pipes was considered once but the scheme was abandoned because it was not economical.

In Japan, laying of steel pipes for river crossing is done by spreading the entire length of welded steel pipes with the ends blanked off on the river bed in advance, attaching the sleigh of steel sheet to the pipe ends to prevent friction between the pipe ends and the river bottom during the pulling of the steel pipe lines, balancing the pipe with buoys tied to the pipe ends so the pipe ends will not touch the river bottom or the pipe line will not float over the river, by pulling the line by the winch which is set up at the opposite side of the river. Further, rollers should be used in pulling the steel pipe over the land area. The pipe should be secured by anchors of concrete blocks every 30 meters from the point where the pipe starts submerging. Flexible couplings should be used at both ends of the steel pipe laid on the river bottom.

5-4. Construction Schedule

It is recommended that construction work be carried out in accordance with the attached construction work schedule. It is desirable that the period of all construction work be set for two years as described in the construction schedule and the contract for construction work be handled as follows.

1) Supply and Installation
   a) Supply and installation of equipment, machinery, electrical equipment and collateral joints, adjustable couplings, tec.
   b) Supply of supply main, rising main, distribution main, adustable couplings and all valves.
2) Civil Works and Pipe Laying Works
   a) Civil work for the intake tower, reservoir, treatment plant and other various structures.
   b) All piping work except those covered in 1)- a)

5-5. Dispatch of Engineers

It is recommended that the following engineers be dispatched for the construction work in view of the special construction methods for facilities for raw water, work for laying distribution main across the river and chemical experiments following the trial run of the plant etc.

	Engineers and Technicians	No. of personnel	Term(month)
1	Civil Engineer	1	4
	Civil Technician	1	5
2	Mechanical Engineer	1	5
	Mechanical Technician	1	6
3	Chemical Engineer	1	4
	Chemical Technician	1	5

Also, besides the construction cost, expenses for dispatching the above engineers has been set at M$171, 250. 00.

5-6. Designing

In addition to the construction cost N$ 103, 300. will be necessary for designing. This sum does not include the expense for geological and various other surveys necessary, should the construction site be changed.

Chapter 6. Costs of Construction and Maintenance

6-1. Construction Cost

6-1-1. Intake and Water Rising Main

Machinery, Electric Equipment and Instruments	M$48, 300
Piping, Valves & Fittings	4, 200
Civil Works	126, 600
Sub-Total	179, 100

6-1-2. Treatment Plant

Machinery, Electric Equipment and Instrument	M$440, 900
Piping, Valves and Fittings	77, 600
Civil Works	342, 900
Sub-Total	861, 400

6-1-3. Supply Mains

Machinery, Electric Equipment	M$58,100
Piping, Valves and Fittings	605,000
Civil Works	108,200
Sub-Total	M$771,300

6-1-4. Distribution Mains

Machinery, Electric Equipment	M$47,000
Piping, Valves, & Fittings	334,600
Civil Works	271,600
Sub-Total	M$653,200
Total	CIF M$2,465,000

6-1-5. Unloading Fee and Transportation

Total	M$117,292
Grand Total	M$2,582,292

6-2. A Breakdown of Construction Cost

6-2-1. Construction expenses

	Machinery, Electric Equipment & instruments	Piping, Valve and Fittings	Civil Work
Intake & Water rising Mains	M$48,300	M$4,200	M$126,600
Treatment Plant	440,900	77,600	342,900
Supply Mains	58,100	605,000	108,200
Distributions Mains	47,000	334,600	271,600
Sub-total	594,300	1,021,400	849,300
Total		M$2,465,000	

6-2-2. A Breakdown of Construction Funds

	Foreign funds	Domestic funds	Total
Intake and Water Rising Mains	M$52, 500	M$126 ,600	M$179, 100
Treatment Plant	518, 500	342, 900	861, 400
Supply Mains	663, 100	108, 200	771, 300
Distribution Mains	381, 600	271, 600	653, 200
Unloading Fee and Transportation Costs		117, 292	117, 292
Total	M$1, 615, 700	M$966, 592	M$ 2, 582, 292

6-3. A Breakdown of Estimated Construction Cost

	1969	1970	Total
Intake and Rising Mains	M$179, 100	M$ --	M$179, 100
Treatment Plant	512, 500	348, 900	861, 400
Supply Mains	604, 600	166, 700	771, 300
Distribution Mains	185, 200	468, 000	653, 200
Total	M$1, 481, 400	M$983, 600	M$2, 465, 000

6-4. Operation and Maintenance Cost

6-4-1. Personnel Expenditure

Type of Work	Number of workers	1 shift	3 shifts
Superindentant	1	16.00 M$/D	16.00 M$/D
Senior Attendant	3	8.67	26.00
Junior Attendant	3	5.58	16.75

Pump operater (B)	1	5.33 M$/D	5.33 M$/D
Labour Odd-job Worker	1	4.67	4.67
Total	9	40.25	68.75
Total (year)		M$14,691.25	M$25,093.75

6-4-2. Power Cost

(1) Power, consumed (18 - hour operation)

Apparatus	Wattage	Number of apparatus	Time	Power consumed
Intake Pump	11.0 kw	2	18 hr	396.0 kwh/D
Rapid Saturation Apparatus	2.2	1	18	39.6
Alum	0.75	1	0.5	0.4
Flocculator	2.2	2	18	79.2
Supply Pump	55.0	2	18	1,980.0
Air Compressor	1.5	1	6	9.0
Illumination and Calculating Apparatus.	20.0	1	8	160.0
Pump	11.0	1	18	198.0
Lime Injector	0.2	2	18	7.2
Total				2,869.4 kwh/D

(2) Power Cost

(a) Operating hours per day 18 hours

(b) Power consumption per day 2869.4 KWH/Day

(c) Unit power cost between 6.30 P.M. and 9.30 P.M.

MCent 21 / KWH

Unit power cost between hours other than the above hours

MCent 7.5 / KWH

(d) Power Costs

1) Cost for 15 hours $\frac{15}{18}$ x 2,869.4 KWH x 7.5 Cents

= M$179.$\underline{34}$

2) Cost for 3 hours $\frac{3}{18}$ x 2,869.4 KWH x 21 Cents

= M$100.$\underline{43}$

3) Total (1) + (2) M$279.$\underline{77}$ / Day

4) Power costs per year

279.$\underline{77}$ /D x 365 d/year = M$102,116.$\underline{05}$/ year

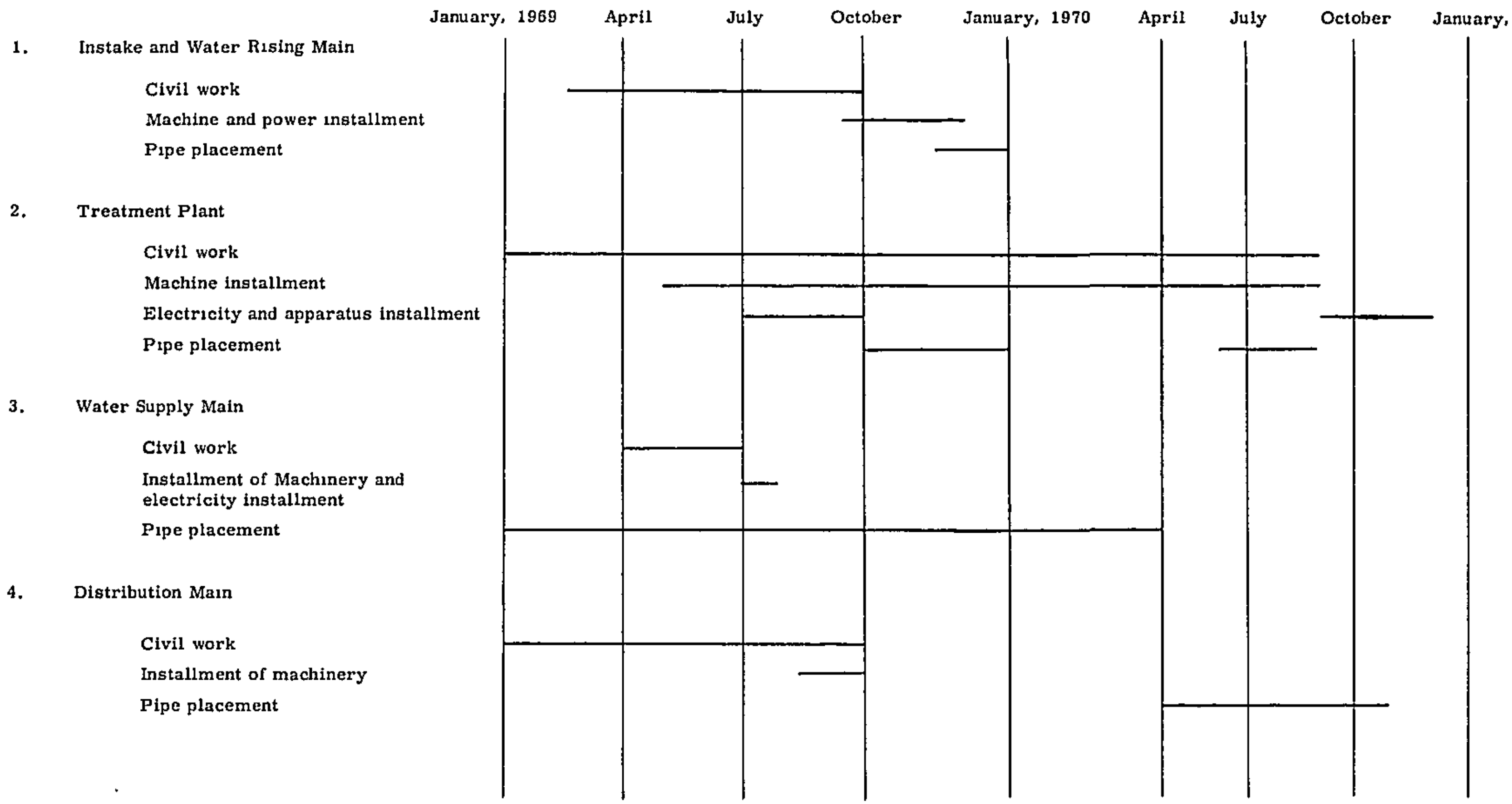
6-4-3. Chemicals

	Daily consumption	Unit cost	Chemical cost
Alum	210 lbs/d	0.088 M$/lb	18.48 M$/D
Slaked Lime	210	0.069	14.49
Chlorine	32	0.70	22.40
Total			55.37 M$/D
Total cost of chemicals yearly		M$20,210.05	

6-4-4: Unit Cost of Water Supply

Labor cost	M$25,093.75
Power cost	102,116.05
Chemical cost	20,210.05
Total	147,419.85
Per day	403.89
Per gallon	0.00038
Per 1,000 gallons	0.38/1,000

Table of Construction Work Plan (Kamaman)



Chapter 7. Financial Plan, Water Charge and Others

The financial plan is shown in a seperate table. In its preparation, Malaysia agreed to the following points:

(1) Repayment will be made in equal installments over a 30-year period, with a 5.75% interest rate.

(2) A financial plan will be prepared which covers a ten year period from the date when the water supply begins.

(3) Water charges will be M$1.00 per 1,000 gallons

(4) Operation and maintenance cost collection covers every expenditure including the collection of water charges.

(5) Two percent of the total construction cost will be included in the provision for replacement and minor extension.

SCHEDULE OF ESTIMATED SUPPLY, REVENUE AND EXPENDITURE

(KEMAMAN)

1 Year	2 Estimated supply per day in 1,000 gals.	3 Estimated supply for the year 1,000 gals.	4 Estimated Revenue M$	5 Present Worth of Revenue M$	6 Repayment of Capital M$	7 Operation and Maintenance Cost M$	8 Provision for Replacement & Minor Extension M$	9 Total Expenditure for the year M$	10 Present Worth of Total Expenditure M$	11 Remarks (Balance in Present Worth) M$
1971	757	276,422	276,422	260,528	182,561	110,568	51,646	344,775	324,950	- 64,422
1972	784	286,069	286,069	254,115	"	114,427	"	348,634	309,692	- 55,577
1973	810	295,716	295,716	247,573	"	118,286	"	352,493	295,107	- 47,534
1974	837	305,363	305,363	240,962	"	122,145	"	356,352	281,197	- 40,235
1975	863	315,021	315,021	234,281	"	126,008	"	360,215	267,892	- 33,611
1976	889	324,657	324,657	227,552	"	129,863	"	364,070	255,177	- 27,625
1977	916	334,304	334,304	220,841	"	133,721	"	367,928	243,053	- 22,212
1978	942	343,950	343,950	214,143	"	137,580	"	371,787	231,475	- 17,332
1979	969	353,597	353,597	207,491	"	141,439	"	375,646	220,429	- 12,938
1980	995	363,244	363,244	200,910	182,561	145,298	51,646	379,505	209,904	- 8,994