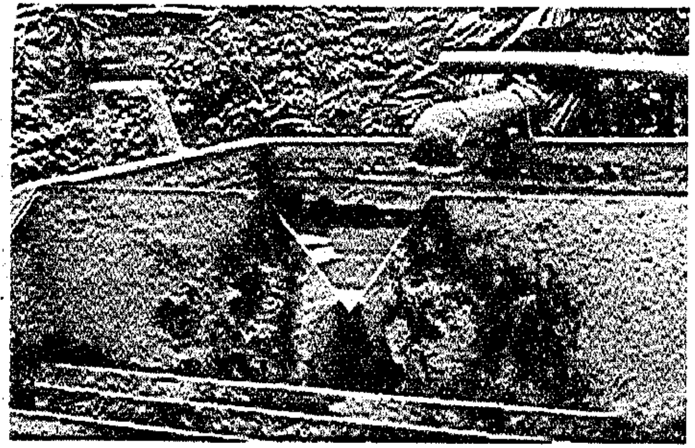
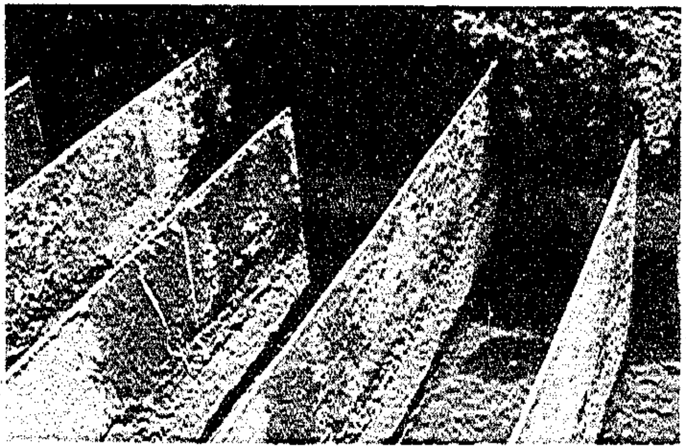
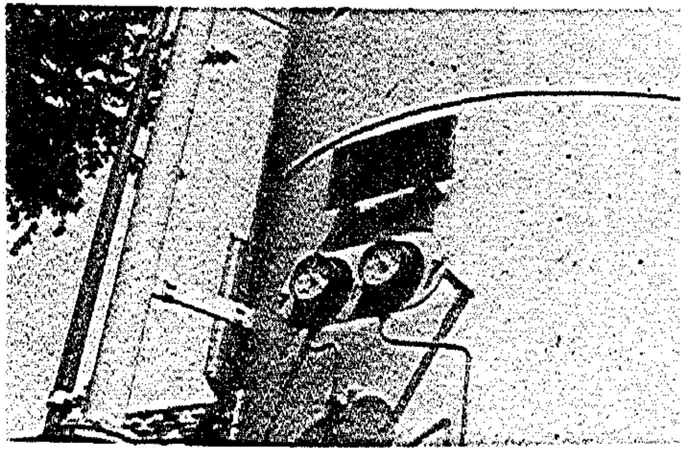


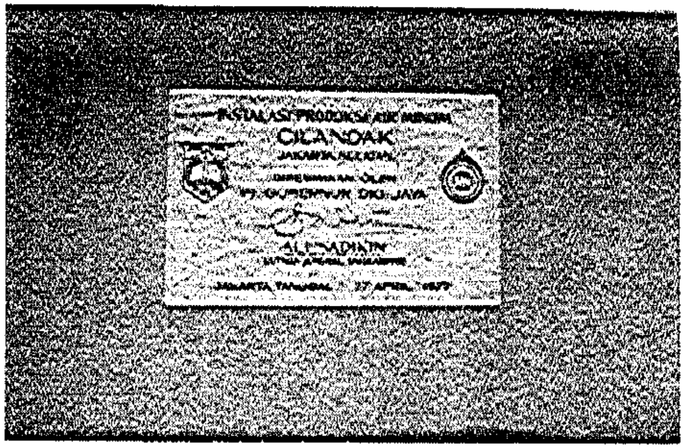
66. Pesing Mini Plant



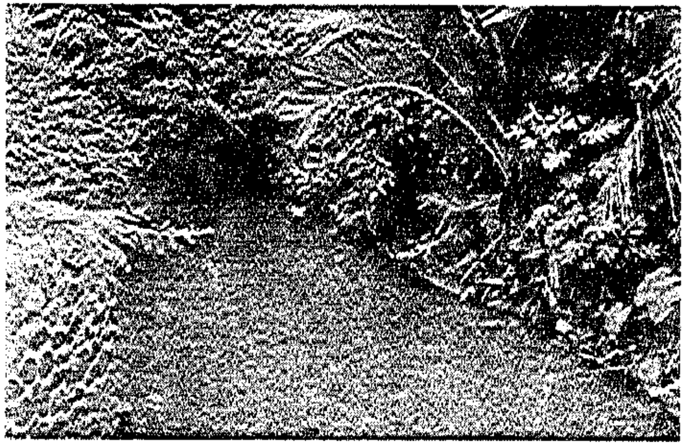
67. Mini Plant (5 l/sec)



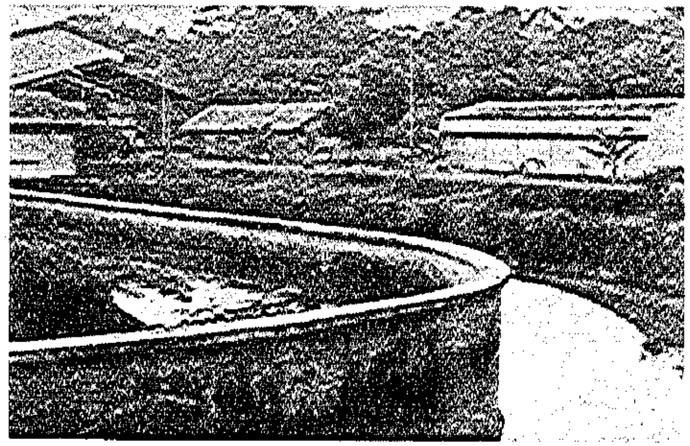
68. Mini Plant



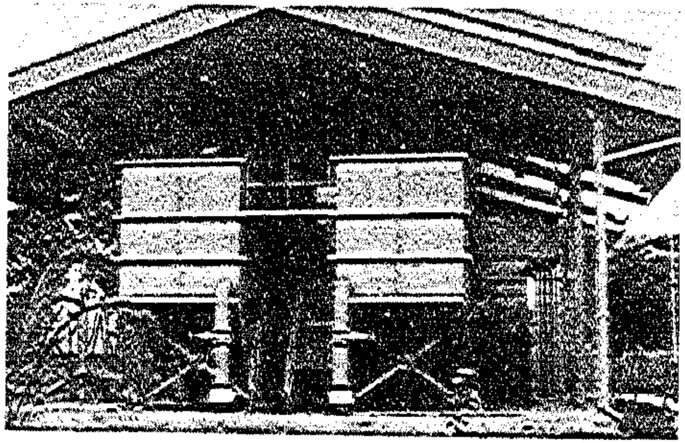
69. Cilandak Mini Plant (200 l/sec)



70. Water Source, Krukut River

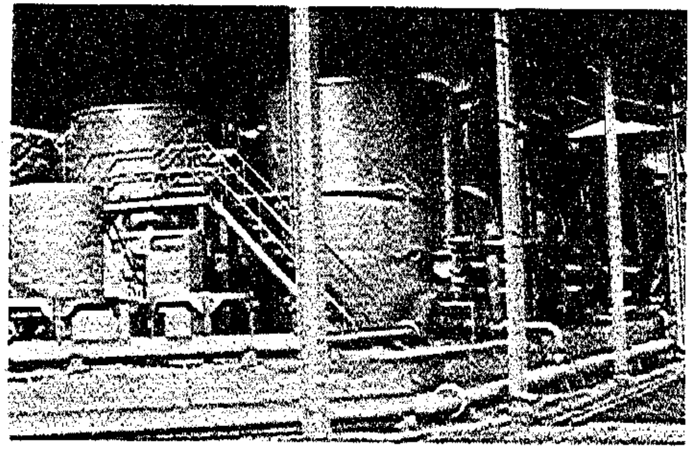


71. Mini Plant Intake Canal



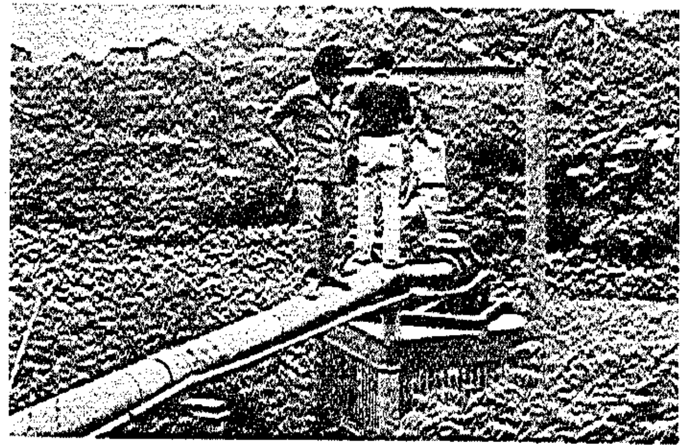
72. Cilandak
Mini Plant
(1 - Unit
50 l/sec)

73. Cilandak
Mini Plant
(100 l/sec)

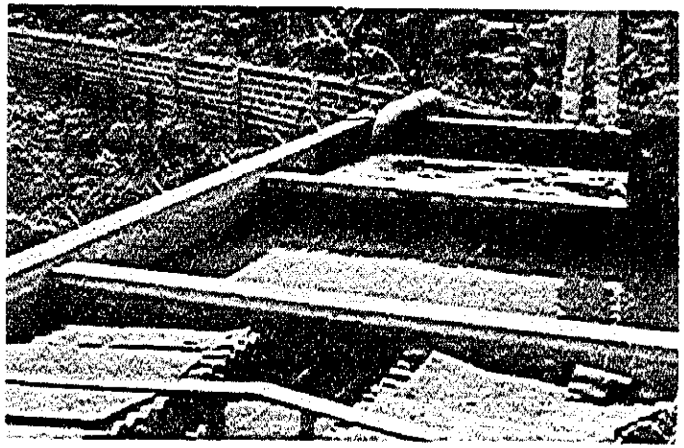


74. Mini Plant
Cilandak

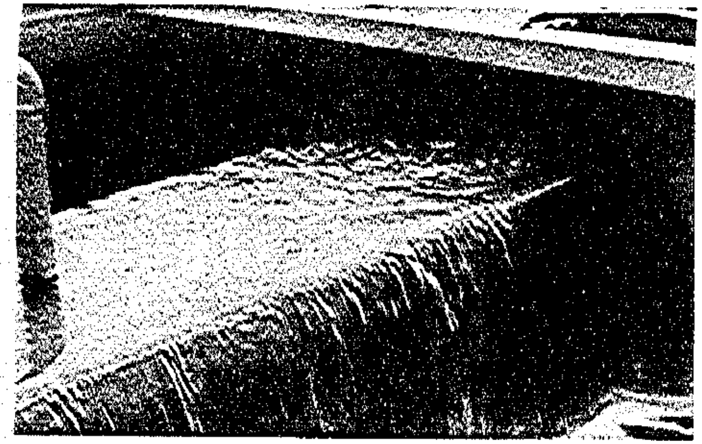
75. Cengkareng
Mini Plant



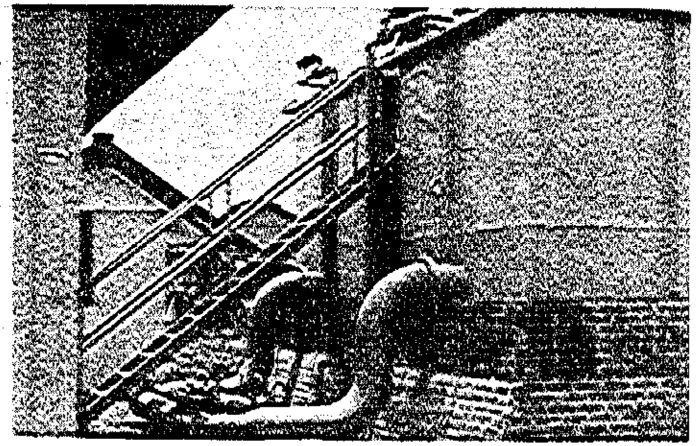
76. Intake Point
from Anke River



77. Mini Plant
(50 l/sec)

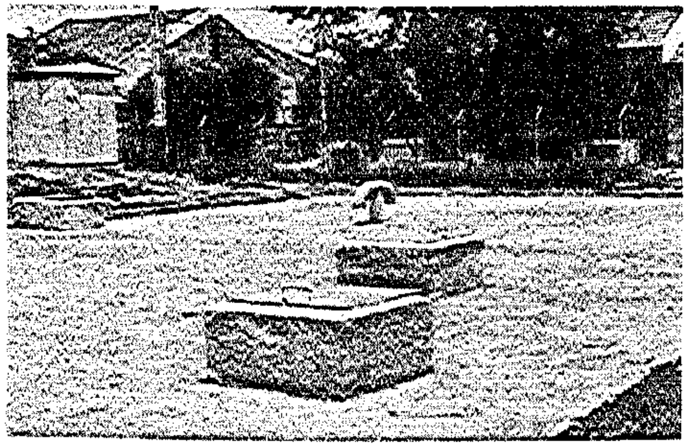


78. Mini Plant



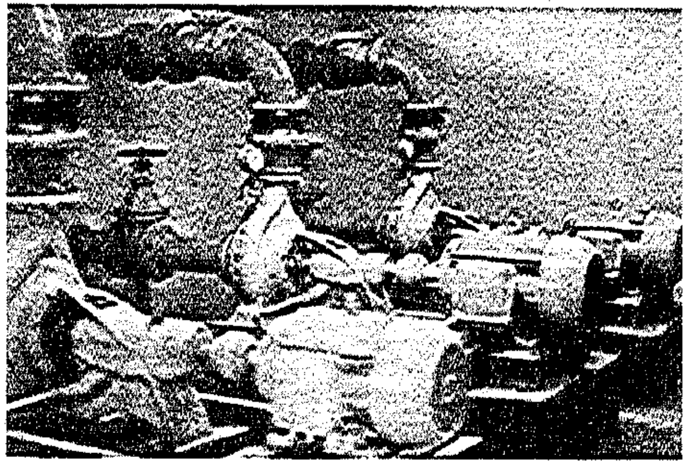
79. Mini Plant

(50 l/s x 2)



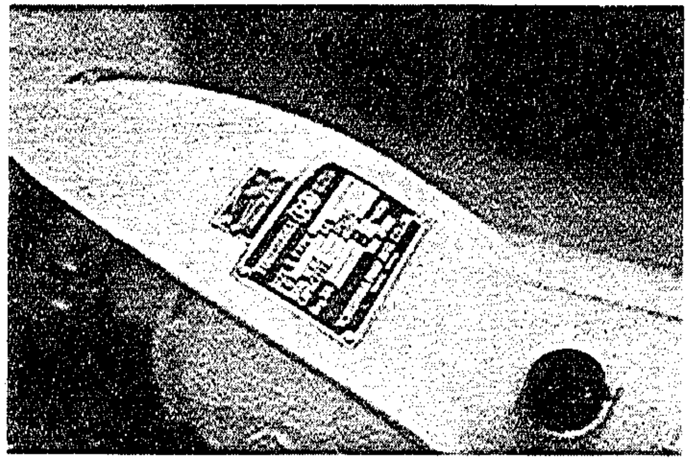
80. Mini Plant

Reservoir



81. Distribution

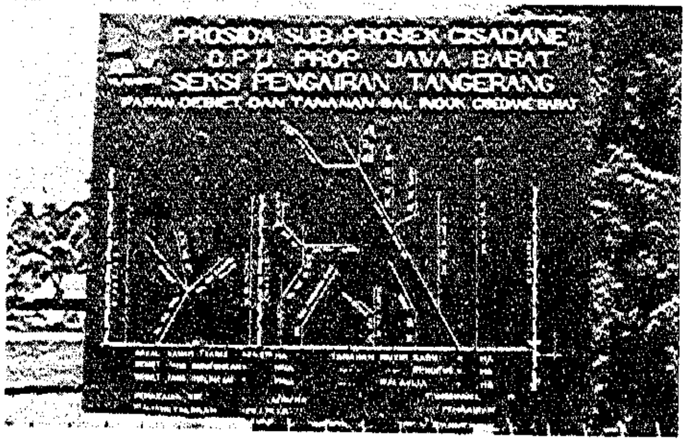
Pump



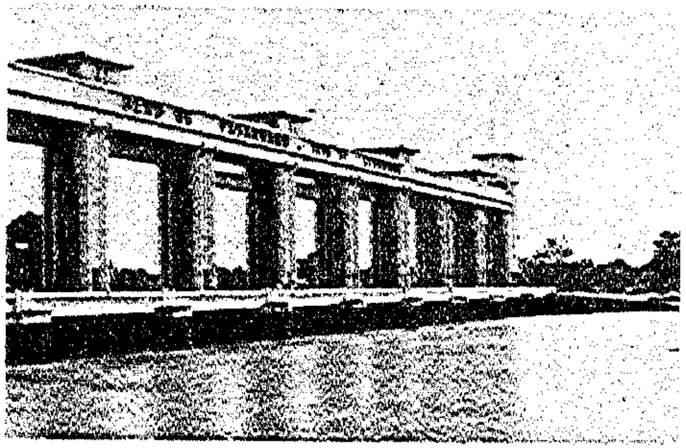
82. Distribution

Pump, Torishima

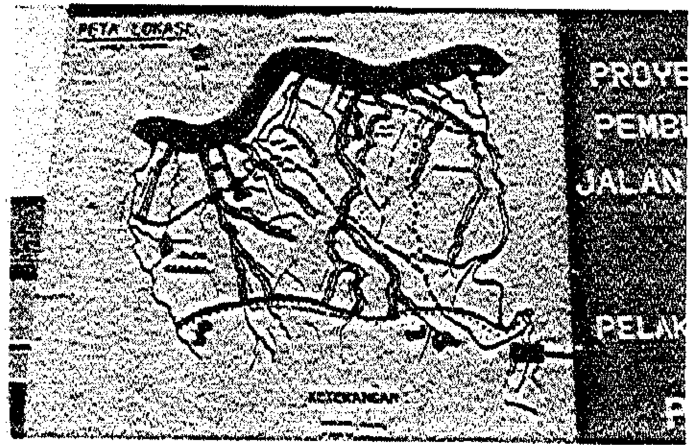
Pump , Osaka



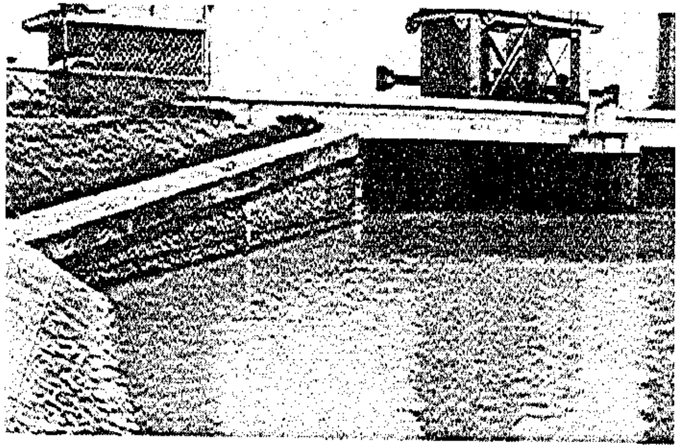
83. Guide Map of Prosida Irrigation at Pasarbaru Weir



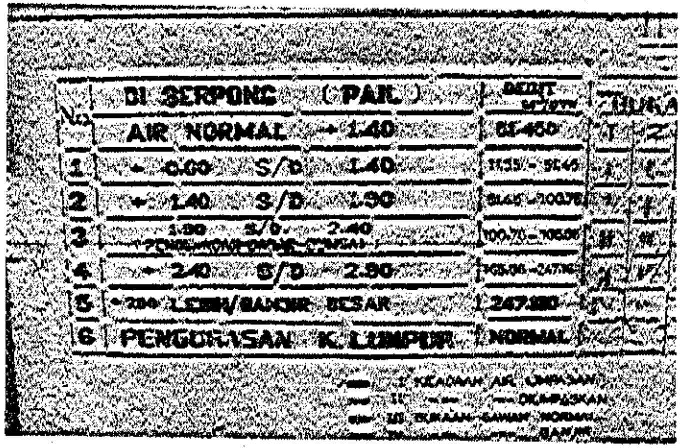
84. Cisadane River at Pasarbaru Weir, Tangerang



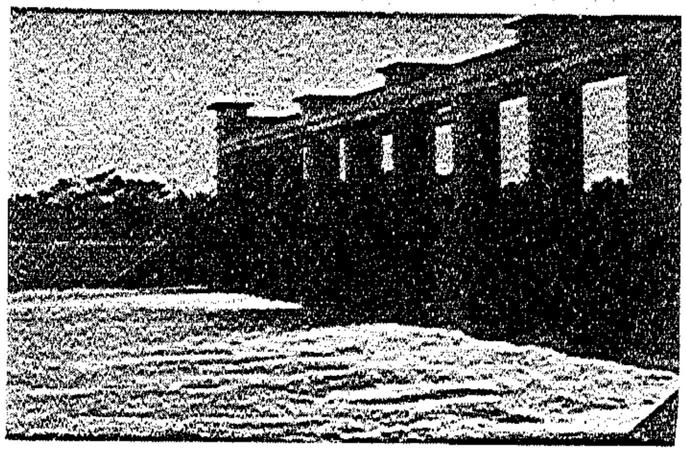
85. Prosida Irrigation Guide Map



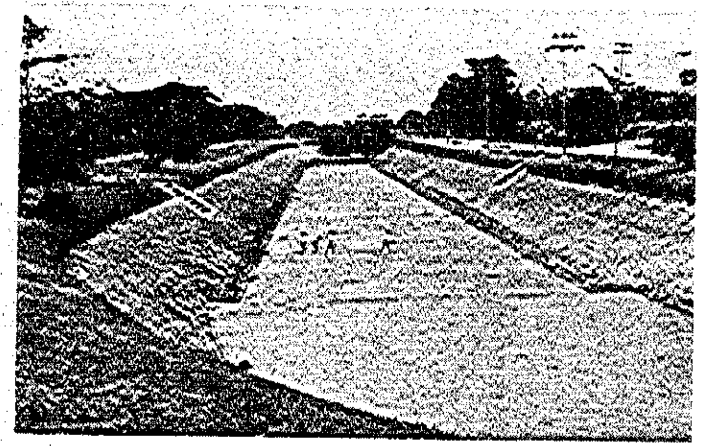
86. Pasarbaru Weir and Gauge Stuff



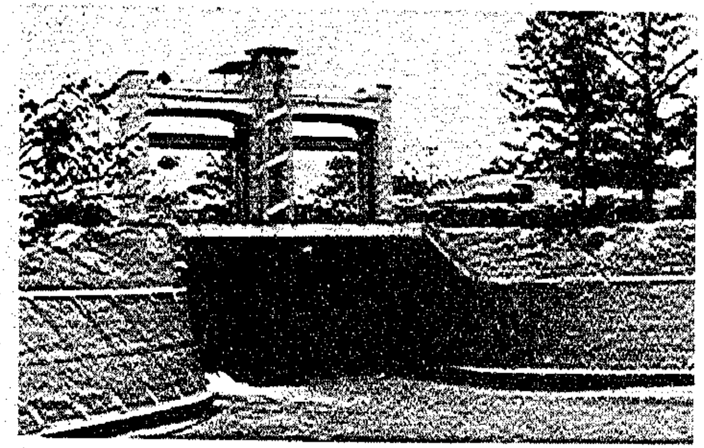
87. River Discharge Table at Pasarbaru Weir



88. Pasarbaru Weir, Outflow of Cisadane River



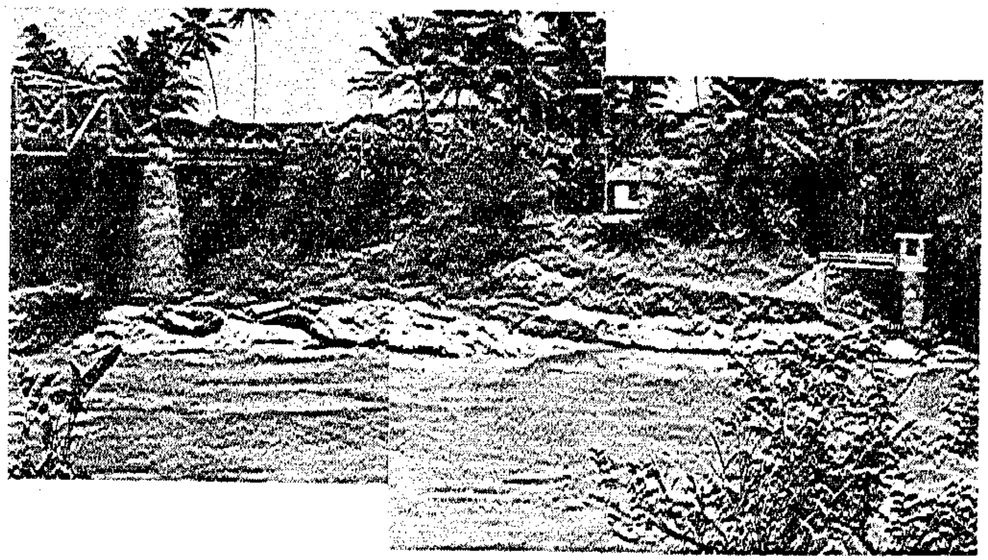
89. Pasarbaru Weir
Silt Trap for Irrigation



90. Pasarbaru Weir
Gate of Mookervaart Canal to Jakarta

91. Mookervaart Canal to Jakarta

92. Cisadane River at Serpong



93. Cisadane River and Serpong Gauge Station

MASTER PLAN FOR
JAKARTA WATER SUPPLY DEVELOPMENT PROJECT

M3. APPENDIX MIII-2

WATER QUALITY AND TREATMENT PROCESS

This Appendix MIII-2, Water Quality and Treatment Process, consists of;

I. Report and Data on Water Quality and Treatment Process, and

II. Supplement to Report and Data on Water Quality and Treatment Process.

APPENDIX MIII-2

I. REPORT AND DATA ON WATER QUALITY AND TREATMENT PROCESS

Water Quality and Treatment Process

Contents

ATTACHMENTS

Introduction

Present water supply of Jakarta City mostly relys on the Pejompongan and Pulogadung treatment plants. Due to the recent deterioration of raw water qualities for the above plants caused by the pollution of the rivers, it has become difficult to produce safe water constantly.

This report deals with an overall review and analysis of data on water quality and treatment conditions of the existing water supply system. Based on the review and analysis, improvement of treatment processes in terms of chemical applications for the plants of Pejompongan and Pulogadung are studied to produce safe water. In addition, suggestion on the practice of water quality analysis to be applied for proper operation is also made in the report.

Raw water improvement for the existing plants for long term operation considerating alternative methods is studied based on the data and surveys on water quality of possible water sources and their environenmtal conditions. The alternatives are (1) employment of pre-treatment process to the existing plants to remove pollutants from the present raw water and (2) alteration of water intakes to where desirable quality of water is available.

Finally, study for future raw water intakes is made from the view point of the water quality and its treatment process, which are most important factors to select intake points for the Immediate and Future water supply programs.

Taking into consideration of the above studies, improvement methods for the existing plants and future water intakes will be defined in the Master Plant and Feasibility Study including cost comparison.

1. Raw Water Quality of the Pejompongan and Pulogadung Plants

1.1 Pejompongan Plant

a Conditions of Raw Water

The Pejompongan Plants, which consist of Plants I and II, take water from the Banjir Canal. The water of the canal mainly consists of mixed water of the Ciliwung River and the West Tarum Canal. A part of water of the Ciliwung River is diverted into the Banjir Canal at Manggarai by gate system after the water of the West Tarum Canal is discharged to the river at Kel Kampung Melayu as shown in Fig. 1.

Presently, the water of the intake point of the Plants is heavily polluted, because the Banjir Canal and the Ciliwung River along its source in the city area receive much inflow of domestic wastewater and garbage.

The West Tarum Canal and the Ciliwung River are not polluted where are no densely populated areas.

In the future, however, it is feared that water pollution will be intensified more than the present conditions due to the increase of population in the water basins.

b. Variations and Fluctuations of Water Quality

Variations and fluctuations of the raw water quality of the Pejompongan for six years from 1978 to 1983 are shown in Figs 2 to 5.

Annual average concentrations of Ammonium, Organic Matter and M-Alkalimity, which are pollution indexes of water, increased every year. Concentration of Dissolved Oxygen was under 5 ppm in annual average.

The above pollutant parameters fluctuated widely by month, and higher concentrations were observed in the dry season.

Hourly fluctuation of synthetic detergent concentrations was also wide, as seen in Fig 6.

From the above facts, the following are considered concerning the conditions of the raw water quality of the Pejompongan Plants.

i Water pollution has been accelerated year after year by inflow of increasing domestic wastes to the sources.

ii The water quality varies monthly and concentrations of pollutant are abnormally high in the dry season.

iii Hourly fluctuations of pollutant concentrations are wide in range, affected by dischages of domestic wastes to the sources.

1.2 Pulogadung Plant

a. Conditions of Raw Water

The plant takes raw water from the Sunter River. The river joins with the Cipinang River at 1 km upstream from the intake point. The Cipinang River receive water diverted from the West Tarum Canal mainly in the dry season as shown in Fig 1.

Water basin of the Sunter is currently being developed as residencial area, and the river is receiving dischage from the inhabited area along the river. The Cipnang River basin also has been developed as housing and industrial areas, and the river water is similarly polluted with discharged waters.

On the other hand, the areas along the West Tarum Canal are rather sparsely populated, and the Canal water level is higher than the ground level of the adjoining areas except the section from the crossing point with the Buaran River to the Canal end. Therefore, the Canal is not so much polluted as the Sunter and the Cipinang Rivers.

b. Monthly Fluctuation of the Water Quality

Concentration of pollutants, Organic Matter, M-Alkalinity and chloride, were changable in seasons and high from June to November in 1982 as shown in Fig 7 and Table 2.

Organic Matter concentration was as high as 70 ppm in June and July, five times of that of Pejompongan raw water.

1.3 Water Quality of Water Sources

(1) Pejompongan Plants

Raw water taken in for the Pejompongan Plants comes from the following water sources. Their conditions are outlined as follows.

a. West Tarum Canal and Jatiluhur Dam

The West Tarum Canal is one of the main water sources for the existing Jakarta water supply, for the Pejompongan and Pulogadung Plants, which originates from the Jatiluhur Dam and flows to the end of the canal and on its way to Jakarta receives diverted water from the Cibeet, Cikarang and Bakasi Rivers as shown in Fig. 8.

According to the data prepared by NEDECO 1983, the canal water consists of 62 % to 95 % of the Bekasi River water which flows into the canal at Bekasi and water of the said Dam accounts for only 2 to 24 % of the canal water.

Water quality data of the Jatiluhur Dam and the West Tarum Canal surveyed by DPMA and Jabotabek study team are shown in Tables 3 to 6. The Dam Water is found to be polluted to some extent, judging from the presence of low concentration of Ammonium, Organic Matter (KMn04) and BOD as well as a few number of Faecal Coli.

The water of the Canal was investigated by NEDECO in four sections along its flow as shown in Table 5 and Fig. 9. According to the investigation water quality parameters and their concentrations are almost same in all sections except number of Faecal Coli and concentration of Ammonium, both of which show an increment in the east section between Bekasi and Jakarta.

The Canal water between the Bekasi and the Buaran Rivers has low concentrations of Ammonium, COD and Faecal Coli, but such concentrations increase between the Sunter River and the Canal end.

As described above, the Canal water is considerably good except in the section before the Jakarta area, and meets the Raw Water Standards for Drinking Water Supply.

b. The Ciliwung River

The water quality of the Ciliwung River is measured at two points of Condet and Pejaten by PDAM and one point at Manggarai. The former two points are before and the latter one is after receiving water from the West Tarum Canal. Summaries of results are show in Table 7 and 8 respectively.

The water at Condet and Pejaten was found slightly contaminated, but the concentrations of Organic Matter and Ammonium were below and Dissolved Oxygen was above that specified in the Raw Water Standard. Water at Manggarai, downstream of the former two points, was obviously polluted with waste water.

c. The Banjir Canal

As described in the section 1.2, water of the canal at the intake point of the Pejonpourgan shows various kinds of pollution, beyond the Raw Water Standard. Its water is becoming seriously worse at the downstream due to increasing inflow of various wastes to the canal.

(2) Pulogadung Plant

This plant is taking mixed water of the Sunter River, the Cipinang River and the West Tarum Canal, for the Canal water is diverted into the Cipinang River, and this river joins the Sunter River at upstream of the intake of the plant. Conditions of the two rivers and the Canal are briefed below.

a. The West Tarum Canal

Please refer to the foregoing subsection.

b. The Sunter and Cipinang Rivers.

The data mentioned in Table 9 indicates that concentrations of pollutant of both river water were seriously high comparing with those of the water of the Pulogadung intake point. The water of the Cipinang had worse quality than that of the Sunter.

2. Chemical Applications and Treatment Conditions.

2.1 Pejompongan plants I and II

Alum and Lime are constantly used for coagulation in both plants, and polymer of Zuclur or Macro Floc has been dosed with Alum expecting effective coagulation with sedimentation in the plant I.

Annual and monthly fluctuations of Alum dosage in the plants are show in Fig. 12. Amount of dosage has gradually been increased year by year, and abrupt increase of dasage was recorded in the dry season of 1981 and 1982.

Polymer dosage in the Plant I was between 0.02 and 0.05 ppm, and no increase of dosage by year was observed. Use of polymer together with Alum was effective in coagulation, considering that dosage of Alum in the Plant I was less than that in the plant II.

Annual fluctuations of treated water quality and chemical dosages at both plants are shown in Figs. 13 and 14. Chlorine dosages had small fluctuations, but not annual increase in both plants. Insufficient dosage of chlorine in both plants is observed judging from the existance of Ammonium in the clear water as shown in the above Figs.

2.2 Pulogadung Plant

Alum, Lime and pre-chlorine are ordinarily used for coagulation in the plant. Alum dosage has been changeable in seasons, with a high dosage in the dry period as shown in the Table 12. Its monthly average dosage is higher than those of the Pejompongan Plants, influenced by the raw water having high concentration of organic matters. Presently, PDAM is conducting a study on use of Poly Aluminium Chloride (PAC). For reference, a brief description of PAC, and comparison of PAC and Alum is presented in Appendix

Pre-, intermediate and post-chlorinations have been employed in the plant, and their total dosage of average 6.4 ppm is much more than those of the Pejompongan Plants.

It is considered to be because of such a rather high dosage of chlorine that Faecal Coli was negative in the treated water of the Pulogadung Plant, as shown in Table 13.

2.3 Conditions of Treated Water Quality of the Plants

Present conditions of treated water quality at the plants are briefly described below based on the data by PDAM Jakarta.

Polymer dosage in the Plant I was between 0.02 and 0.05 ppm, and no increase of dosage by year was observed. Use of polymer together with Alum was effective in coagulation, considering that dosage of Alum in the Plant I was less than that in the plant II.

Annual fluctuations of treated water quality and chemical dosage at both plants are shown in Figs. 13 and 14. Chlorine dosages had small fluctuations, but not annual increase in both plants. Insufficient dosage of chlorine in both plants is observed judging from the existance of Ammonium in the clear water as shown in the above Figs.

(1) Faecal Coliform in Treated Water

Number of samples of positive sign of Faecal Coli in treated water is shown in the Table 13 at each plant including other mini plants. The treated water of the Pejompongan I shows the highest percentage of samples of positive sing of Faecal Coli among the three plants, which is 20 % in 1981 and 23 % in 1982. The treated water of the Pejompongan I is worse than Plant II, in spite of taking their raw water from the same point of the Banjir Canal. The treated water of the Pulogadung has had no sing of Faecal Coli so far. It is considered that 1.5 - 3 ppm of chlorine dosages at the Pejompongan Plant I and II was insufficient to remove Faecal Coli in the treated water and 6.4 ppm of total dosage at the Pulogadung Plant, as described above, has been enough to keep treated water free from Faecal Coli.

(2) Treated Water Quality of Pejompongan I Plant

Fig. 13 shows that annual average concentrations of Turbidity, Ammonium, Organic Matter and Residual Chlorine of treated water have increased annually, especially in 1982. The reasons for their rising tendency may be that (1) pollution of the raw water has been increasing annually, (2) chemical dosages are insufficient to cope with the water pollution increase and (3) treatment facilities, especially filters, have deteriorated.

(3) Treated Water Quality of Pejompongan II Plant

Fig. 14 shows annual average concentrations of the same parameters of the Pejompongan I of treated water. Concentrations of Organic Matter and Residual Chlorine have increased year by year, but no rising tendency of Turbidity and Ammonium concentration was found. The concentrations of the three parameters except residual chlorine are rather low comparing with those of the Pejompongan I. That Ammonium and Faecal Coli were detected in the treated water imply that chlorine dosage was insufficient.

(4) Treated Water Quality of Pulogadung Plant

Treated water quality of the Pulogadung is shown in monthly average on Table 15. Monthly fluctuations are wide in quality parameters of Organic Matter, Ammonium and M-Alkalinity. And concentrations of Organic Matter were over the value of the drinking water standard, 10 ppm in May and July 1982.

3. Evaluation of Water Quality and Treatment Conditions

Based on the review of data and survey, water quality and treatment conditions of the three treatment plants are briefly evaluated as follows.

3.1. Evaluation of Water Quality

(1) Raw Water of Pejompongan Plant

a. Water pollution of the source canal has increased every year.

b. Pollutant concentrations, Ammonium, Dissolved Oxygen and BOD, have widely varied by month and day, and were over those of the Raw Water Standard for Drinking Water Supply in the dry season.

c. Main pollution of the raw water occurs in the 4 km section of the Banjir canal upstream of the intake. The section receives domestic wastes and garbage, having 200 - 299 persons/ha of high population density in 1980.

d. It is estimated that the raw water quality will become worse in future due to population growth along the canal as well as increasing inflow of wastes.

(2) Raw Water of Pulogadung Plant

a. Pollutant concentrations have varied by month and day.

b. Concentrations of Organic Matter and M-Alkahinity were higher than those of the Pejompongan plant raw water in 1982 and 1983.

c. Presently, the raw water is polluted by inflow of various wastes to the rivers.

d. It is considered that water pollution of the raw water will be worse in future, as a development of residential area in the water basin of the Sunter is planned.

e. Water of the Cipinang River is worse than that of the Sunter River, and not suitable for water supply use.

3.2. Evaluation of Treatment Conditions and Chemical Applications

(1) Pejompongan I Plant

a. Alum dosage has augmented every year and will increase in future because of increasing pollution of raw water. Much amount of Alum has been necessary in the dry season.

b. Present chlorine dosage of 1.5 to 3 ppm is insufficient for oxidizing pollutant and disinfecting treated water.

c. Activated Carbon treatment is useful for removing oder from the raw water. But the dosage of 1 to 3 ppm is insufficient.

d. Treated water frequently has positive signs of Faecal Coli and Ammonium. Therefore it will be concluded that (1) raw water has become unsuitable for water supply and (2) present chemical applications are not proper to make safe water.

e. Residual Turbidity value of the treated water in 1982 was, sometimes, as high as 3.3 ppm. The reason may be break-through of Turbidity in the filter because of insufficient back washing and propagation of mud balls in the sand bed.

(2) Pejompongan II Plant

a. Alum dosage also increased year by year, and was more than that of the Pejompongan I in spite of using the same raw water. Its seasonal variation is same as the Pejompongan I.

b. Chlorine dosage of 1.5 to 4 ppm is insufficient as treated water frequently has positive signs of Faecal Coli and Ammonium.

c. Activated Carbon Dosage of 1 to 3 ppm is insufficient for removing odor from the raw water.

d. Treated water quality frequently does not meet that of the Drinking Water Standard.

(3) Pulogadung Plant

a. Alum dosage has varied by month because of change of degree of raw water pollution, much in the dry season.

b. Pre-, intermediate and post-chlorination employed is effective to oxidze pollutant and protect propagation of Faecal Coli as can be judged from data of non Faecal Coli in the treated water. But the dosage has been insufficient in the dry season, because positive sign of Ammonium in the clear water is found.

c. Activated Carbon dosage is insufficient for removing odor from the raw water.

d. It is considered that optimum chemical dosage to meet change of raw water quality is difficult because concentrations of pollutant rapidly change according as discharge of wastes changes.

3.3 Recommendations for Improving the Present Conditions

It was ascertained by the overall review of the existing data that the present raw water of the three plants is unsuitable for the waterworks, and the treatment plants are in difficulty to produce safe water. It is, therefore, considered that fundamental improvement of the raw water is necessary. This section describes improvements of the existing plants to produce as safe water as possible using the present raw water. Further, alternative improvements of the raw water are dealt with in the section 6.

(1) Strengthening of Prechlorination

Prechlorine to meet chlorine requirement of the raw water is required to oxidize and remove organic matters and Ammonium from the raw water at sedimentation basin and to get as low value of Turbidity in settled water as possible. Chlorine dosage to meet chlorine requirement is 10 to 15 times of Ammonium concentration as standard. Maximum dosage of chlorine should be kept within 10 ppm, considering the probable production of Trihalomethane in the finished water.

(2) Employment of Intermediate Chlorination (Pejompongan I & II)

As one of causes for Faecal Coli being in the finished water of the Pejompongan I and II, it is considered that Faecal Coli is propagating on and in the sand layer of filter, because of lack of residual chlorine in the settled water. It is therefore, recommended that intermediate chlorination be practiced to the extent approximately 0.5 ppm of residual chlorine is kept in the filtered water.

(3) Strengthening of Postchlorination

Present residual chlorine is in the combined type, which has low power of disinfection as Ammonium remains in the finished water, especially in the dry season. Therefore, postchlorination should be strengthened so that chlorine of free type is kept in the finished water.

(4) Strengtheing of Activated Carbon Treatment

Present dosage of Activated Carbon is less than 3 ppm, which is insufficient to remove strong odor from the raw water. 5 to 10 ppm of dosage and 5 to 10 minutes of retention time would be necessary in the dry season. By Activated Carbon, detergent and heavy metals will also be removed.

(5) Analysis of Ammonium

Quantitative analysis of Ammonium in the raw water is sometimes carried out at the Pulogadung, but at the Pejompongan, Ammonium exceeding 0.6 ppm is not analyzed. As Ammonium concentration in the raw water is very important for deciding dosages of chlorine and Alum, its quantitive analysis should be carried out daily and chemical dosages be decided on the basis of the daily data.

(6) Analysis of Dissolved Oxygen (Pulogadung)

As there is correlation among pollutants and Dissolved Oxygen, the correlation can be used in determining chemical dosage, as is proved at the Pejompongan Plants. It is advisable to perform analysis of Dissolved Oxygen at the Pulogadung Plant as well.

(7) Alum feading by Concentration of Ammonium and M-Alkalinity

As the results of the existing data analysis, it is found that the present Alum dosage is controled by concentration of Ammonium, M-Alkalinity and Dissolved Oxygen in the raw water at the Pejompongan Plant, but not Turbidity value and the results are satisfactory. Therefore, Alum Dosages of the plants should be controled based on the concentrations of Ammonium and M-Alkalinity of the raw water by daily analysis.

(8) Coagulation Test

In coagulation test using Jar Tester, the following items should be observed.

- Frequency : twice a day
- Analysis items of raw water : PH, M-Alkalinity, Ammonium, Turbidity and Color
- Observation items at coagulation : magnitude of floc, sedimentation rate, quantity of settled floc
- Analysis items of settled water : PH, M-Alkalinity, Ammonium, Turbidity and Color, analysed 5 minuted after settleing.
- Judgement of optimum dosage : by size of floc, amount of settled foc, and turbidity value of settled water.

(9) Desludging of Sedimentation Basins

Settled sludge volume in the sedimentation basin is changeable by concentration of Suspended solid or Turbidity of the raw water and dosages of Alum and Activated Carbon. Therefore, desludge amount should be adjusted as required. Clarifyers at the Pulogadung should be operated constantly.

(10) Test of Sand in Size and Uniformity Coefficient

Size and uniformity coefficient of the used sand as well as condition of mud balls in the filter should be checked, and if shortcomings found, they should be corrected to elongate the filter run.

(11) Backwashing of filter

Backwashing of filter should be carried out by reading head loss of each filter and/or checking Turbidity of filtered water.

(12) Foam Removal by Showering

Foam generated by high concentration of detergent, more than 0.5 ppm in the raw water, can not be removed by the existing water treatment process. As employed in sewage treatment system, showering is recommendable.

(13) Removal of Floating Scum (Pulogadung)

Thick floating scum presently exists at the floculation basins of the Pulogadung Plant. It can be removed by employing overflow or shower equipment at the basin.

(14) Training of Operators

Operators of the plants are generally lacking required practical knowledge of water treatment. It is recommendable to give them such practical and fundamental knowledge to operate the plants properly.

As described above, there are a number of improvement items at the existing plants. Items (1), (2), (3), (5), (7), (8), (9), (10), (11), and (14) have high and urgent priorities in order to improve the present undesirable conditions. These items should be put in practice as soon as possible.

4. Evaluation of Mini Plants

4.1 Present Situations of Mini Plants

Mini plant system is employed serving drinking water to areas which are not covered by the Pejompongan and Pulogadung systems, and is under operation of PDAM-Jakarta. Seven mini plants are now operated and new two mini plants and expansion of Cilandak and Muara Karang plants are under planning. They are located mainly in the north and south Jakarta areas as shown in Fig. 15, because piped water is not distributed to the areas. Present total rated capacity of mini plants is approximately 435 l/s, which is 6.3 % of total rated capacity of public water supply in Jakarta. Some of the mini plants located in the north Jakarta area presently have troubles in treatment because of deterioration of raw water.

4.2 Water Treatment Conditions

(1) Water Treatment Conditions

Tables 16 to 20 show summary of the raw water quality and chemical application of the mini plants. The mini plants of Cilandak and Pejaten have ordinary desirable treatment conditions because of good raw water quality.

The Cakung Plant sometimes has raw water of high concentrations of Ammonium and Organic Matter due to inflow of agriculture wastewater to the canal, and treated water occasionally has positive sing of Faecal Coli.

The Cengkareng plant also has polluted raw water as shown in paramaters of Ammonium and Organic Matter in the dry season, because the river at the intake point has almost no flow in the dry season.

The Pesing plant has stopped its operation for three months from August to October, 1982, because saline water flowed backward to the intake point. The produced water of the plant is sold to limited area by vender as there is no distribution pipelines.

The Muara Karang plant takes deteriorated raw water from the Banjir Canal at Jembatan Besi, 6 km downstream from the intake point of the Pejompongan plant. Three quality parameters of the raw water show higher values than the criteria for raw water, and the plant is facing the problems of foam caused by detergent and colored water by wastewater of textile industries existing along the Krukut River.

The Sunter plant also has polluted raw water which has high concentrations of Ammonium and Organic Matter. And data of water quality on 20th May, 1981 indicated 117 ppm of high chloride and 1150 umho/cm of conductivity values. Treated water of the plant often has positive sign of Faecal Coli.

On the other hand, the plants have been operated using same kind of chemicals, i.e., Alum, Chloride and Soda Ash. And the plants of Muara Karang, Pesing, Sunter and Cilandak have been obliged to use Activated Carbon to remove odor. The plants located in the north Jakarta area have high dosages of chemicals comparing with the plants of other areas as raw water quality is deteriorated.

4.3 Evaluation of Mini Plants

Tabel 21 shows evaluation of water sources based on the present water quality in and around the Jakarta. The mini plants located in the north Jakarta, Muara Karang, Pesing and Sunter, have had problem of deteriorated raw water affected by various wastewater. Because their water basins are located in high population density areas of over 200 persons/ha and have discharge of wastewater from various industries. Improvement of the present situations of the raw water quality would not be expected in the near future and the undersirable conditions of quality will become worse by population growth in the future.

It is therefore, recommended that the operation of the above three mini plants should be given up after the completion of expansion works of the Pejompongan and Pulogadung plants and the immediate project of 2,000 l/sec. Mini plants of Cilandak and Pejaten presently have sound operation having rather desirable raw water for drinking water supply. It is considered, however, that water pollution of their sources will become worse gradually in the future as with urbanization of the water basins. Therefore, operations of the plants should be reviewed at the time of completion of the above mentioned projects.

5. Water Quality of Tap Water

Water quality characteristics of the tap water in the city and its pollution will be firstly described, and causes of tap water pollution and their contermeasures will then be discussed in the following sections :

5.1 Characteristics of Tap Water Quality

(1) Feacal Coli in the Tap Waters

Tap water quality is regularly analysed once per month at 50 to 60 points in the existing distribution system by PDAM-Jakarta. Number of samples of Positive sing of Feacal Coli in 1981 and 1982 and water pressure in 1983 are shown in Fig. 16. A large number of samples of positive sign of Faecal Coli appears particularly in north and south areas. Occurrence of positive sing of Faecal Coli has no relation with dry and wet periods as seen in Fig. 17.

(2) Organic Matter

Concentration of Organic Matter in tap water was over 10 ppm in data of July and September, 1982, as seen in Table 22. The value is specified to be under 10 ppm by Drinking Water Quality Standard of Indonesia. While its concentration in months from July to September

1982 was high, it was almost to the allowable limit and rather low from November to May. Fluctuation curve of the concentration is connected with that of Organic Matter in the treated water of the Pejompongan Plant II as mentioned in Fig. 18.

As described above, presently Faecal Coli is positive at high percentage and concentrations of Organic Matter are occasionally over 10 ppm against the fact that a great number of tap water sampled has positive sing of residual chlorine.

(3) Pollution of Tap Water

Tap waters are presently contaminated bacteriologically and by organic matter, as described above, while concnetrations of other quality parameters are below the values specified in the drinking water standard. Countermeasures on bacteriological pollution of tap water especially are needed so as to prevent outbreak of epidemic diseases.

5.2 Causes of Tap Water Pollution

Judging from the existing conditions in regard to tap water quality, the following are considered for causes of pollution.

(1) Infiltration of polluted groundwater into distribution system caused by low pressure less than 1 kg/cm^2.

(2) Insufficient treatment of polluted raw water

(3) Insufficient disinfection by chlorine

As regards the item (1), it is considered that polluted groundwater infiltrates into distribution system, becuase percentages of positive sing of Faecal Coli are considerably high in the north area of Jakarta where prevails especially low pressure under 0.5 kg/cm^2 or sometimes no distribution of water.

Regarding treatment of polluted raw water of the item (2), treated water at the plant has seasonal fluctuations of concentrations of Organic Matter and Ammonium which correspond to changes in the raw water quality. Percentage of positive sing of Faecal Coli in the tap water has close relation with ammonium concentration of treated water at the plants as can be seen in Fig. 19.

Regarding the item (3), it is considered that dosage of chlorine for disinfection is presently not enough at the existing plants and free chlorine hardly exists in the tap water. If raw water has some Ammonium and Organic pollution, curve of residual chlorine changes like the pattern III mentioned in Figs. 20 and 21. Residual chlorine will be of combined type before chlorine dosing of point (c) and free chlorine appears after dosing of point (c). Disinfection power of the combined chlorine in the tap water is not so strong as free chlorine and the combined chlorine requires a long time to keep tap water free from bacteria.

5.3 Countermeasures of Tap Water Pollution

This section summarizes necessary countermeasures to be taken to prevent the pollution of tap water.

(1) Maintenance of Distribution System

In order to prevent infiltration of polluted groundwater to the distribution system, it is important that the water pressure is maintained at more than 1.5 kg/cm^2 in the whole distribution system. The present low water pressure has to be raised to the specified pressure. Requrired water pressure will be kept by distributing sufficient water to the service area to satisfy the existing water demand and by preventing leakage of water from the distribution system.

(2) Elimination of Faecal Coli

To eliminate the presence of Faecal Coli in the treated water, it is vital to analyze water under treatment at stages: before treatment, after settling and after complete treatment, and decide chemical applications according to the results of such analyses. As the raw water quality changes all the time, analysis should be made as often as practicable.

(3) Strengthening of disinfection

In the treated water at the plants, a number of samples showing Faecal Coli positive are detected, as seen in Table 13. It is therefore recommended that post-chlorination be made to the extent to form free chlorine in the supply water.

6. Improvement of Raw Water Quality and Alteration of Water Source

6.1 Introduction

As described in the preceding sections, the plants of Pejompongan and Pulogadung are taking deteriorated raw water and experiencing difficulties in treatment, resulting in production of treated water hardly meeting the drinking water standard. No immediate improvement of all the source water can be expected, because the environment of the rivers is worsening due to rapid population increase. Therefore, it is indispensable either to improve the raw water quality by pre-treatment or to replace the existing intakes to more suitable water sources. Pre-treatment methods and water sources together with intake points to be recommended will be examined in the following.

6.2 Alternative Study of Pre-treatment

(1) Target of Pre-treatment

Raw water for the Pejompongan and Pulogadung Plants are so severely polluted that the ordinary treatment method cannot produce safe potable water. To remedy this situation, pre-treatment before the ordinary treatment is indispensable. Hence, several pre-treatment methods which can meet the following treatment target will be briefly discussed below. The target is values of pollutants which the ordinary treatment method can handle.

a.	Ammonium	: under 0.5 ppm as NH4-N
b.	Faecal Coli	: under 1×10^4 MPN/100 ml
c.	Detergent	: under 0.5 ppm
d.	Dissolved Oxygen	: over 5 ppm
e.	B O D	: under 5 ppm

(2) Comparison of Pre-treatment Methods

Table 23 shows four pre-treatment methods with their characteristics

a. Ozone oxidation method is effective in removing Faecal Coli, Detergent, DO and BOD. But there are almost no examples of its employment as pre-treatment for waterworks, because (1) much amount of ozone is required for treating polluted matters. (2) cost of electric power is expensive, (3) it is feared to produce unknown toxic matters in treated water, and (4) colored water will be produced in case of the existance of Manganese ion in the raw water.

b. Activated sludge method is usally employed in sewerage treatment mainly to remove BOD and Organic Matters in the water. The method is effective in treating wastewater having high concentration of BOD, more than 50 ppm, but there are no precedents of its employment in waterworks. As it is considered that removal efficiency of pollutants of rather low concentration is low, and its operation is somewhat difficult, this method is not necessarily recommendable.

c. Fixed Biological Film Contact Oxidation Method (FBF) is a treatment process which is designed to form a biological film and let pollutants contact with the film. There are a number of cases where this method is employed in waterworks in Japan, and all the installations are working successfully. The method is recommendable, if it is proved to be more feasible than to replace the existing intakes.

d. Aerated Lagoon method is devised by the same principle with FBF method which utilizes biology in water. It is not considered feasible to employ this method, because it needs a wide space for contact pond, say for 1-2 weeks detention, to remove pollutants.

Considering from the characteristics of treatment of the four methods, FBF method is most recommendable for the pre-treatment.

6.3 Alternative Study for Water Source and Intake Point

(1) Water Source and Intake Point to be studied

The West Tarum Canal is the only water source presently available for water supply, although there are other water sources under study, but not available immediately. The Canal meets the short term needs in quantity and the water quality is fairly good, not requiring special pre-treatment. Therefore, recommendable intake points along the Canal will be studied based on the existing data, taking also into consideration the future environmental conditions expected to take place.

(2) Environmental Conditions and Water Quality

As described in the Working Paper of "Water Source Study:, the Water of the West Tarum Canal originates from the Jatiluhur Dam. The Canal, on its way, diverts water to distributaries and also take in water from the Cibeet, the Cikarang and the Bekasi Rivers, and flows down to its end at the crossing points with the Cipinang River.

As regards the environmental conditions along the Canal, the neighboring area upstream of the boundary of Jakarta is sparsely populated and not industrialized. The water quality of the Canal is good, as shown on Table 5, and Figs 9 and 10.

However, the neighboring area from the crossing point with the Sunter River to the end of the Canal has a rather high population density, 100 to 149 persons/ha. The Canal receives direct discharge of wastewater from the inhabited area, and besides there are toilets and washing places on the Canal. The water of this section of the Canal is polluted.

On the other hand, future development of housing along the Canal is planned by DKI Jakarta in the Jakarta administrative area. Population density along the Canal in the City area will increase to approiximately twice the present density in the year 2005. Therefore, it is considered that the canal water in the area will be more polluted by inflow of domestic wastewater. Development of industries along the Canal in city area is not planned, so chemical pollution will not increase.

Meanwhile, Bekasi and Cikarang cities are located along the Canal and their future city plans have influence on the canal water quality. Presently, the cities have rather low population density of less than 30 persons/ha and industries are located in areas not affecting the Canal water, and so the canal water has desirable quality for raw water of waterworks. The region including Bekasi and Cikarang, however, is anticipated to develop as residential and industrial areas, as planned by the Cisadane-Jakarta-Cibet Water Resources Development Plan as shown in Fig. 22, and along with the development the Canal water may be increasingly polluted. It is therefore recommended that measures be taken not to pollute the Canal water when the development plan is implemented.

(3) Alternative Intake Points.

Major considerations in selecting a new intake point are that the distance from the existing treatment plants is as short as possible, the construction cost is least, and water quality is good. The following three points are possible candidates for such an intake.

A. End of the canal, for the Pejompongan
B. 2 km east of the Sunter River, for the Pulogadung or both plants.
C. Outside of DKI Jakarta boundary, for the Pulogadung or both plants

Alternative A is a least cost solution for the Peompongan Plant, but qualitatively it is not recommendable because the water at the end of the Canal is polluted, sometimes exceeding the value specified by the Raw Water Standard, as shown on Table 6.

Regarding Alternative B, the present water quality is satisfactory, but it is feared that the water quality will deteriorate as with population growth in the neighboring areas of the Canal. Therefore, this Alternative is less recommendable than Alternative C.

Alternative C is recommendable, because the water is presently good, and even in the future the present water quality is expected to be maintained, considering that no special development is planned in the area.

(4) Proposed Water Treatment Process

Water treatment processes and chemical applications based on the evaluation of the raw water quality at the alternative three intake points are shown in Table 24. Difference of treatment processes of the alternatives is whether aeration chamber at intake point is necessary or not. The raw water at the end of the Canal may require aeration to reduce concentrations of the pollutants such as Ammonium, Ordor, Organic matter etc. When aerated water is conveyed through the transmission pipe, the pollutants will be removed by oxidation by means of biological film propagated on the inside of the pipe.

The water at 2 km east of the Sunter River presently has desirable quality not requring aeration system. But in the future, aeration will be needed.

The water outside of the boundary has good quality at present, and it may not change in future. Aeration is not necessary to employ.

As regards chemical application for the alternative plans, same dosing points and method are assumed for the three alternatives, and also same average dosing amounts are assumed except prechlorine. The water at 2 km east of the Sunter River will require higher dosage of prechlorine in average.

Conclusively, from the standpoint of the water quality and treatment, the intake point outside of DKI Jakarta boundary is most recommendable. In making final decision of the intake point, it is desirable to take into consideration the economy of construction works.

Further, which method, pre-treatment of raw water or alteration of water source, should be decided after their comparison from the standpoint of construction, operation and economy.

7. Consideration on Intake Point for Immediate Project

What was discussed in the preceding Section 6 will be applied to the new intake to be constructed for the immediate project. It should be located on the West Tarum Canal, and the location of the intake is preferable to be upstream of the city boundary, considering that the water quality is good and required treatment peocesses are rather simple.

Although the water quality has presently no problem, it is feared that the Canal water will be deteriorated in the future, because some industrial development is schemed along the upstream reaches of the Bakasi river and along the Canal. It is therefore recommended that adequate preventive measures be taken against the probable discharge of pollutants from the industries into the river and the Canal.

8. Water Sources for Future Water Supply

There are two water sources proposed for future water supply of Jakarta, that is, one, Canal 1 from the Jatiluhur Dam, and two, the Cisadane River. The feasibility study of Canal 1 has already been completed. The development of the Cisadane River has been studied by NEDECO, and presented in the report titled "Cibeet Irrigation, Flood Control and Water Supply Study". The following are characteristics of water quality of the two water sources.

1) Canal 1

a. Turbidity value will be usually low, compared with that of the West Tarum Canal (WTC) water.

b. Floc after coagulation will be light, which is characterized by algal growth in the dam water.

c. It is feared that eutrophication of the Jatiluhur Dam water will occur by inflow of treated sewarage water of the Bandung City through the rivers. Odor and algal treatment of the water of Canal 1 might be necessary in future as odor and algal will grow by eutrophication of the dam water. So, it is recommended that total nitrogen, phosphorus and flow quantity of the inlet water to the dam are measured in every month in order to estimate future conditions of the dam water.

d. Concentration of Ammonium and number of Faecal Coli will be less than that of the WTC water with no inflow of waste water on its way to the end of the Canal 1.

e. The water will be little agricultural and heavy metal pollutions.

2) Cisadane River

a. Turbidity value will be high and changeable by season.

b. The water will be likely to be polluted by inflow of wastes to the river.

c. Concentrations of pollutant will be higher than that of the Canal 1 water.

Table 25 shows estimated treatment processes and chemical applications, which are designed, for reference, with raw water taken from the Jatiluhur dam inpoundment and the Cisadane River.

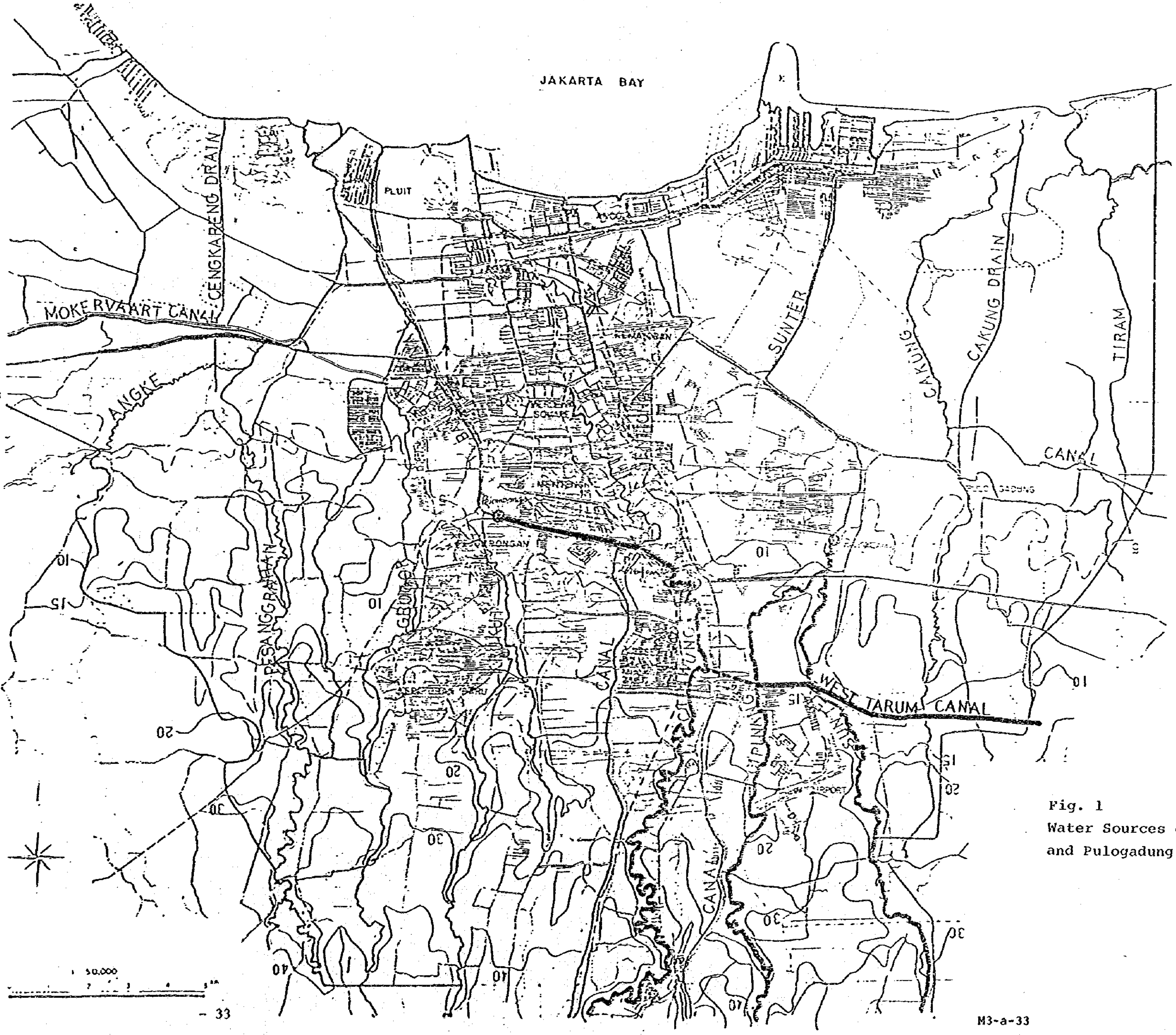


Fig. 1
Water Sources of Pejompongan
and Pulogadung Plants

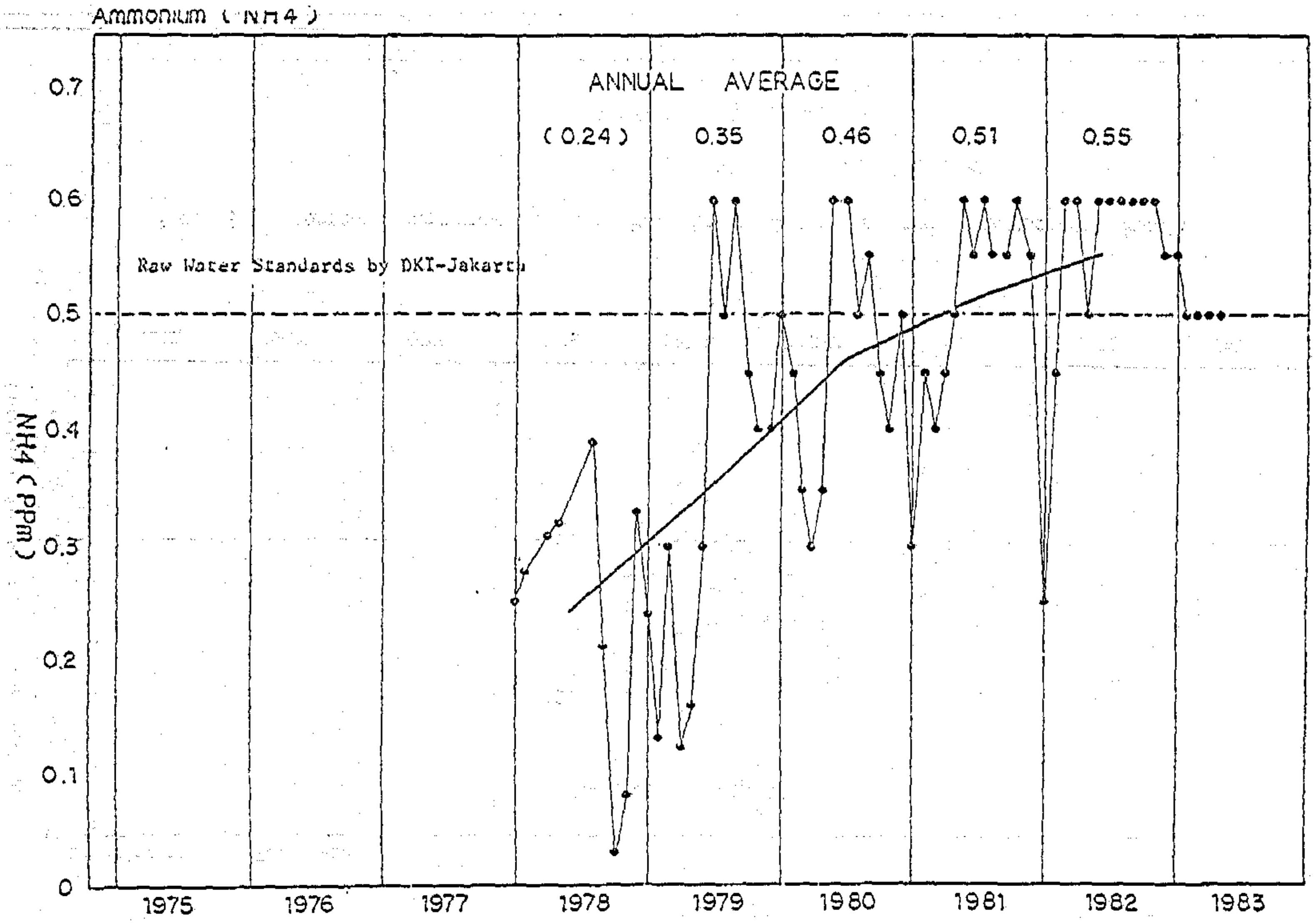


Fig. 2 Monthly Fluctuation of the Raw Water Quality of the Pejompongan Plants

Note: Quantitative analysis of Ammonium more than 0.6 ppm has not been conducted.

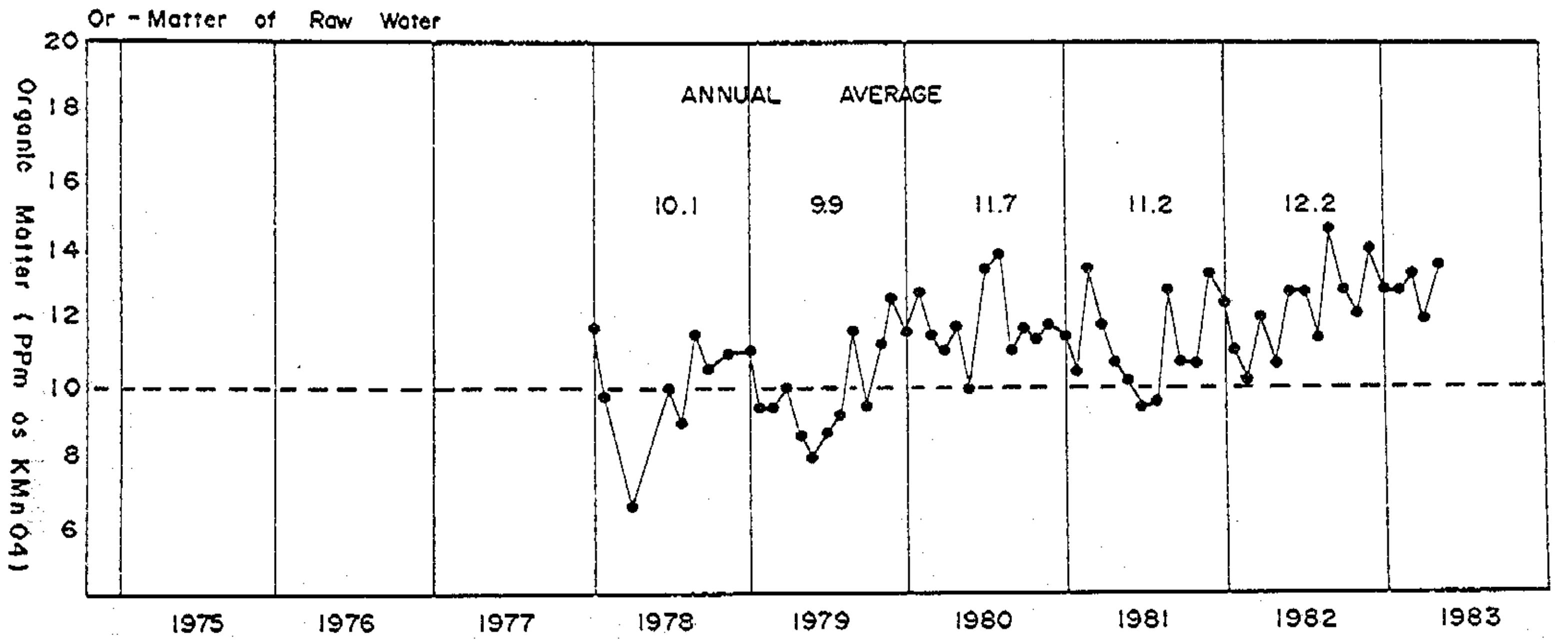


Fig. 3 Monthly Fluctuation of the Raw Water Quality of the Pejompongan Plants.

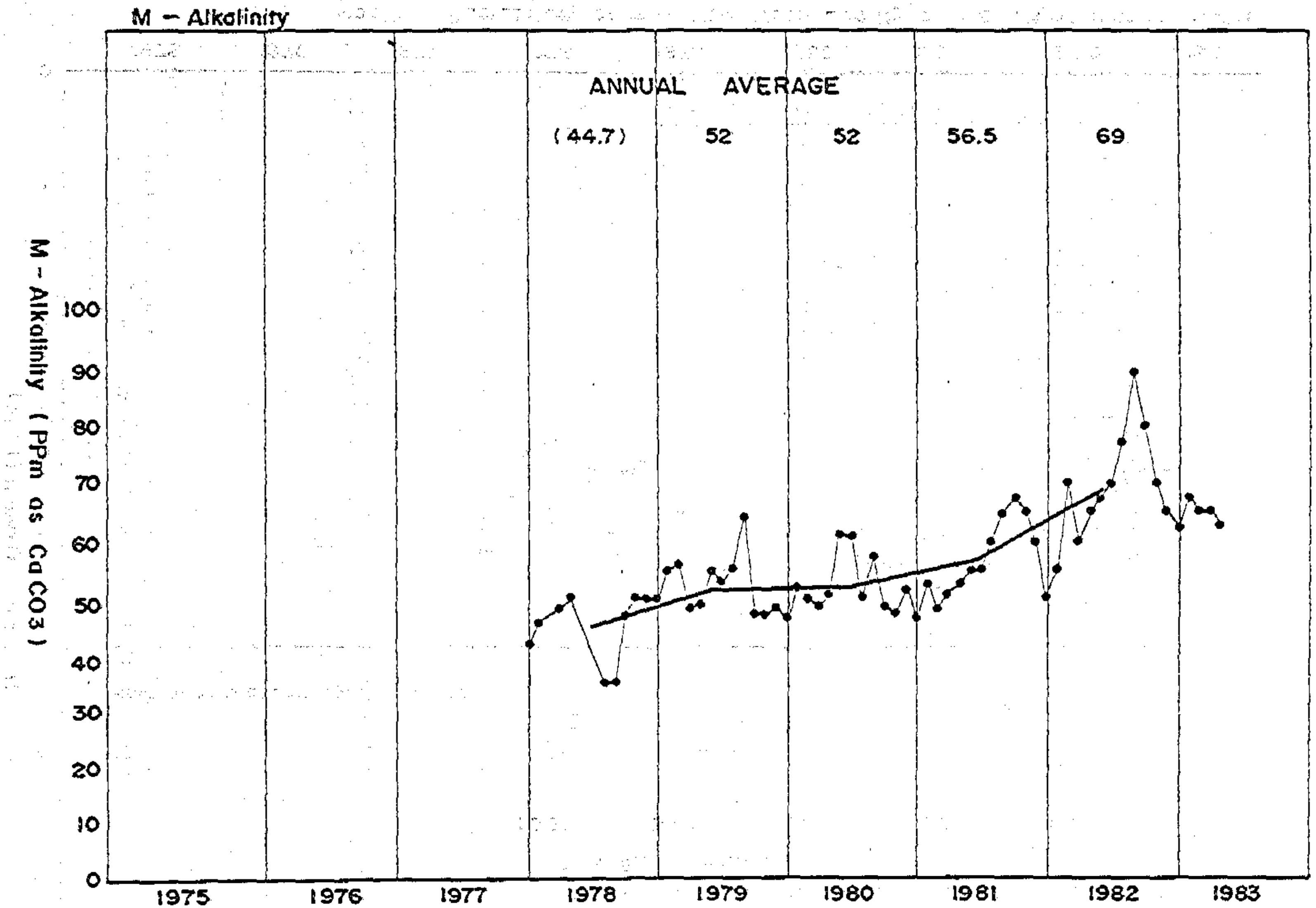


Fig. 4 Monthly Fluctuation of the Raw Water Quality of the Pejompongan Plants

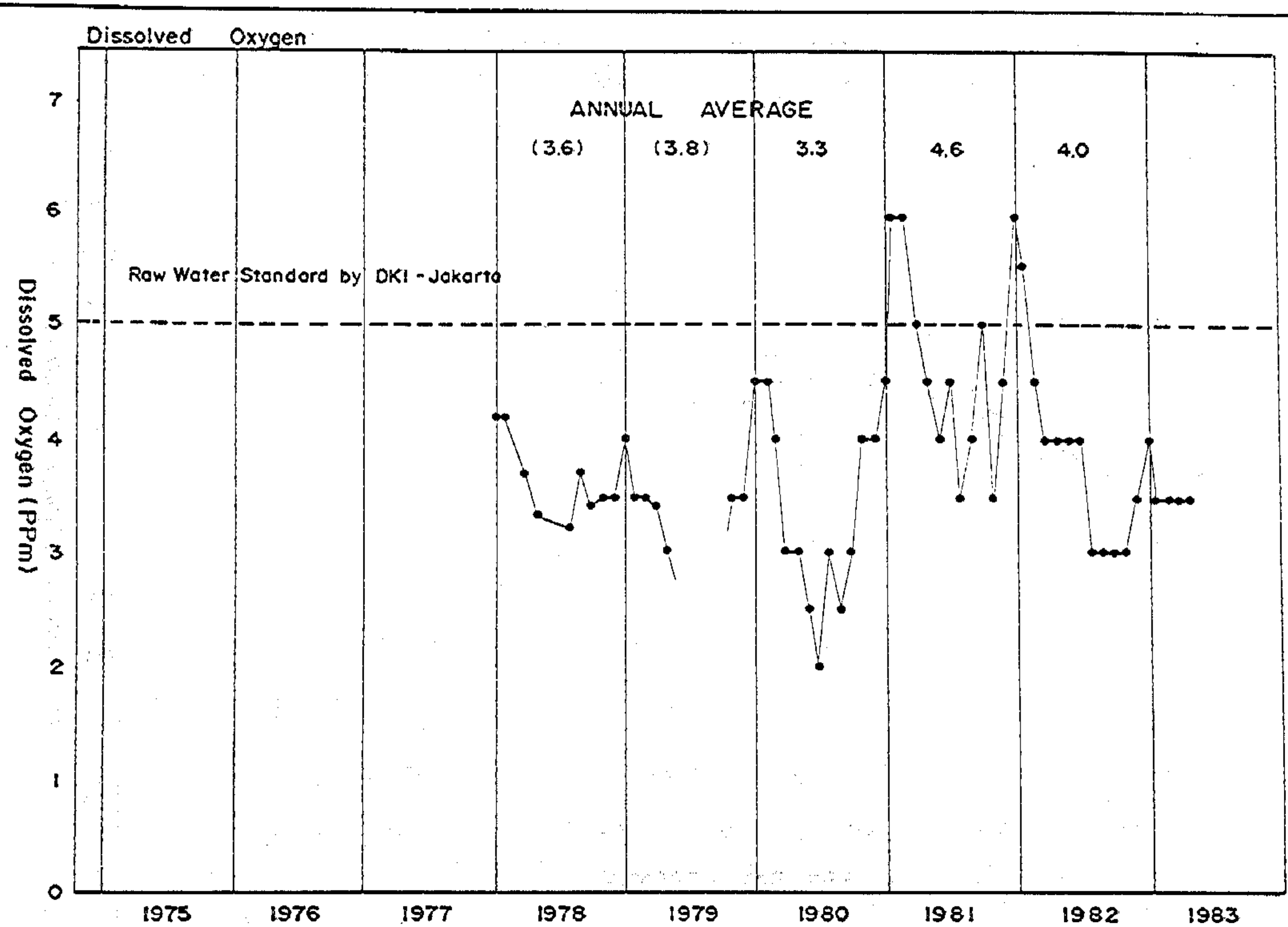


Fig. 5 Monthly Fluctuation of the Raw Wate Quality of the Pejompongan Plants

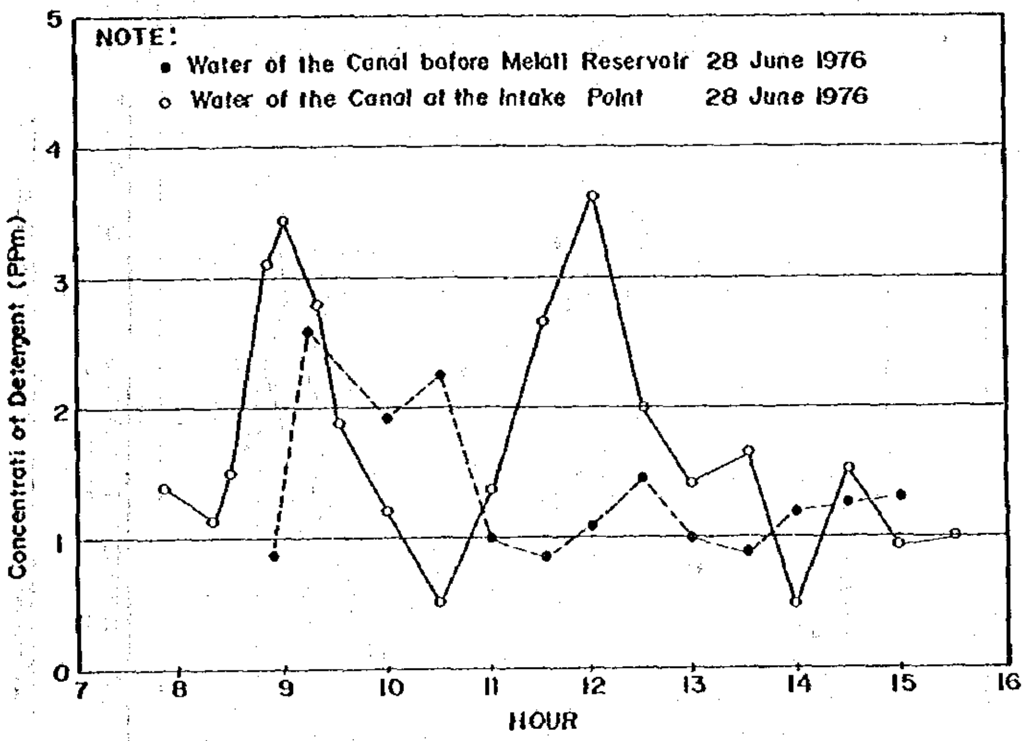


Fig. 6 HOURLY FLUCTUATION OF DETERGENT CONCENTRATION ON THE BANJIR CANAL

NOTE :

Quoted from a report of "Survey of Synthetic Detergents in the Banjir Canal" made by Cipta Karya and PAM JAKARTA.

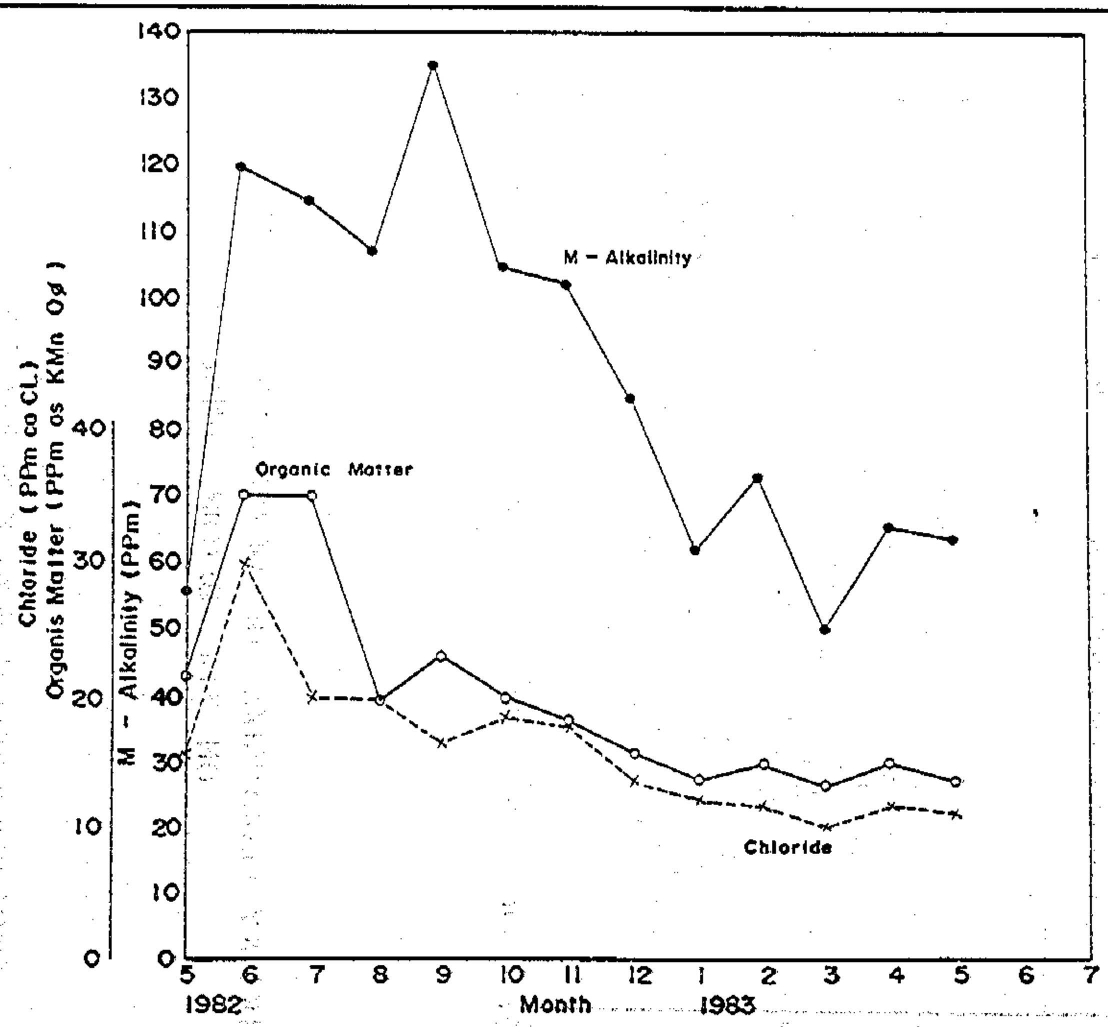


Fig. 7 MONTHLY FLUCTUATIONS OF RAW WATER QUALITY AT THE PULOGADUNG PLANT (BY PAM)

Table 2 Raw Water Quality of the Pulogadung Plant

Month		PH	Turb (NTU)	M-Alkalinity	Organic Matter	Choloride	Hardness (oD)	Color	Iron	Manga-nese	Ammonia	Sulfate
1982	(5)	7.0	70.0	56.1	20.9	15.7	2.3	7150	Pos	Neg	1.9	Neg
	6	7.1	88	119.5	34.4	29.5	3.7	7150	Pos	Neg	Pos	Neg
	7	7.1	72	115.4	34.6	19.5	3.9	7150	Pos	Neg	Pos	Neg
	8	7.1	40	107	19.7	19.8	4.3	Black	Pos	Trc	Pos	Neg
	9	7.1	52	136	22.9	16.7	4.9	150 7	Trc	Neg	Pos	Neg
	10	7.0	74	105	20.1	18.5	4.4	125	Trc	Neg	Pos	Neg
	11	7.0	102	102	18.3	17.9	4.8	125	Pos	Neg	Pos	Neg
	12	7.0	153	85	16.1	13.9	3.8	150	0.94	Neg	74	Neg
1983	1	6.9	190	61.4	14.3	13.2	3.9	7 150	Pos	Neg	Pos	Trc
	2	6.8	91	72.8	15.6	12.5	3.6	7 150	0.74	Neg	0.70	Neg
	3	6.9	124	50.1	13.4	10.4	3.8	7 150	0.95	Neg	0.70	Neg
	4	6.8	101	64.1	14.5	11.9	3.2	7 150	2.7	Pos	1.0	Neg
	5	6.9	57.2	63.5	13.3	11.2	3.1	7 150	1.4	Trc	1.2	Neg
Average		7.0	95	90	19.8	16.2	4.0	-	-	-	-	-

Fig. 8 LOCATIONS AT WHICH WATER SAMPLES WERE TAKEN BY DPMA FOR WATER QUALITY TESTING

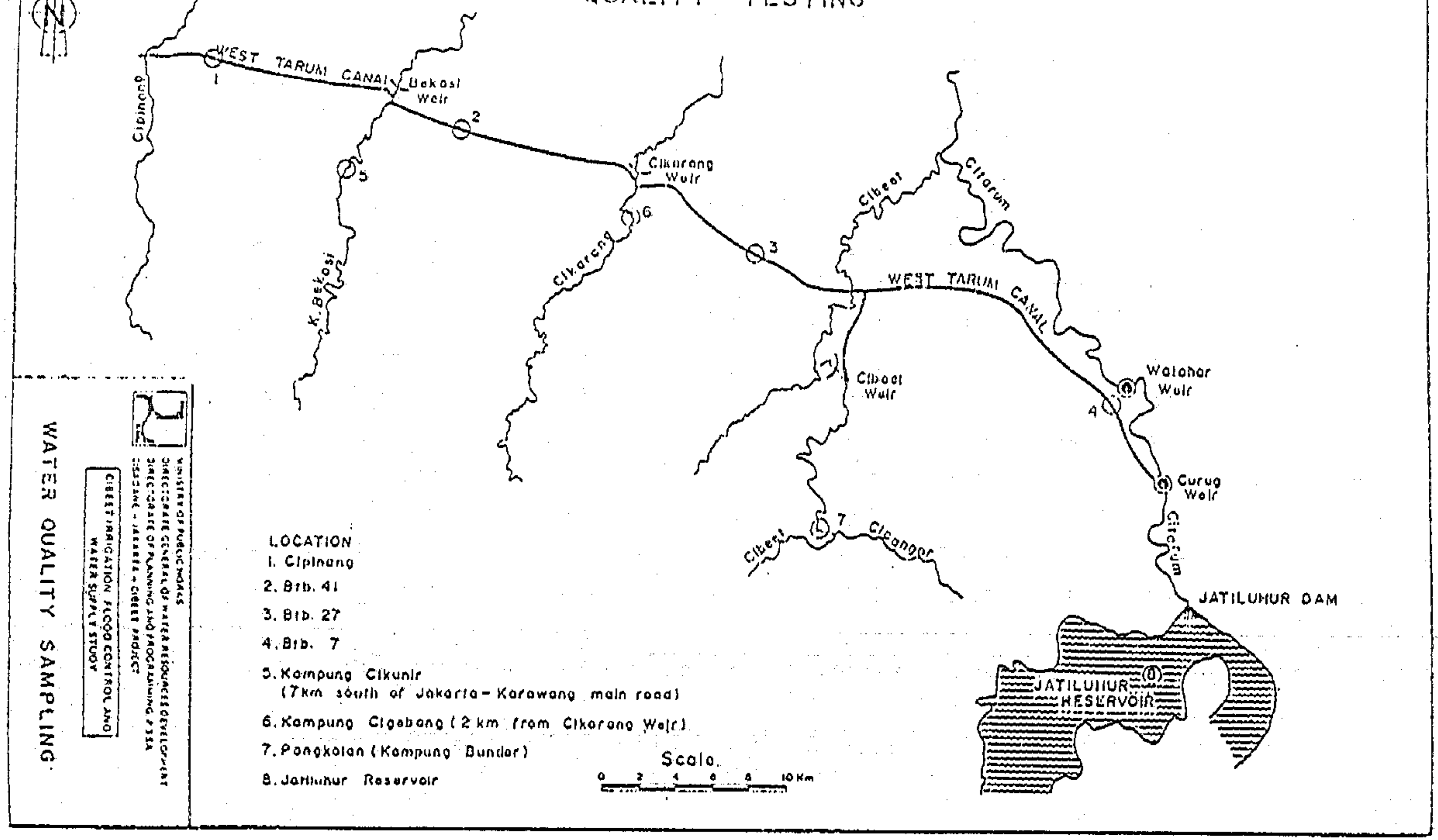


Table 3 Quality of water in Jatiluhur Reservoir (DPMA, 1979-80)

Parameter	Unit	Range Minimum	Range Maximum	Average Value	Standard Deviation
Temperature	°C	25	31	29	2
Conductivity	μmho/cm	127	295	167	46
Total Suspended Solids	mg/l	8	65	21	14
Transparency	cm	50	125	96	24
pH	-	6.9	8.6	8.0	0.4
Alkalinity (as $CaCO_3$)	mg/l	34	67	49	7.5
Dissolved Oxygen	mg/l	6.0	7.9	7.0	0.5
Calsium	mg/l	9.6	18.0	14.8	2.3
Magnesium	mg/l	1.7	5.8	3.4	1.2
Iron	mg/l	0.1	1.8	0.5	0.4
Manganese	mg/l	0.03	0.17	0.05	0.04
Chloride	mg/l	7.1	9.9	8.6	0.8
Sulphate	mg/l	2.1	13.0	5.4	2.4
Ammonium - N	mg/l	< 0.002	0.45	< 0.063	0.14
Nitrate - N	mg/l	< 0.06	0.99	< 0.36	0.28
Nitrite - N	mg/l	< 0.002	0.016	< 0.006	0.006
COD	mg/l	2	19	7.3	4.5
BOD	mg/l	0.4	2.9	1.3	0.6
$KMnO_4$	mg/l	0.3	8.6	2.0	1.9
Faecal Coli (MPN/100 ml)	-	400	2.1×10^7	1.8×10^6	-

Notes : - Values are based on 17 monthly samples during 1979 and 1980 by the water quality laboratory of DPMA

- Faecal Coli values recorder are very irregular with inexplicably high extreme values for conditions in Jatiluhur reservoir.

Table 4 Raw water quality parameters in Jatiluhur Reservoir and West Tarum Canal, and drinking water standards

Parameter	Unit	Canal Water			Jatiluhur Water			drinking water standards		
		Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Desirable	Max.permitted
Colour	PtCo	15	30	24	24	15	12	-	5	50
Turbidity	mg/1 SiO_2	48	300	105	6	27	14	-	5	25
Iron	mg/1	0.43	2.78	1.5	0.12	0.38	0.31	-	0.1	1
Manganese	mg/1	0.01	0.38	0.12	0.02	0.12	0.03	-	0.05	0.5
Ammonium	mg/1	0.002	0.69	0.22	0.002	1.08	0.32	-	-	0
Nitrite	mg/1	0.002	0.029	0.005	0.002	0.003	0.002	-	-	0
Organic Matter	mg/1 KMnO4	5.3	26.0	11.7	2.5	7.4	4.7	-	-	10
Faecal Coli	MPN/100 ml	2.3×10^4	4.6×10^6	8×10^5	15	230	135	-	-	0

Note : - Canal Water based on 12 sampling results from sections Cikarang-Bekasi and Bekasi-Jakarta of West Tarum Canal

- Jatiluhur Water based on 6 sampling results from Jatiluhur
- Previous sampling in 1979 and 1980 of Jatiluhur Water shows much higher bacteriological concentrations.
- Turbidity measurements of samples taken from 15 to 17 April 1982 are not represented. It is considered that these extremely high turbidities in excess of 2,000 mg/1 SiO2 do not represent a normal situation.

Table 5 Quality of water in West Tarum Canal and in sources

Parameter		Unit	West Tarum Canal Section				Sources			
			Curug - Cibeet	Cibeet - Cikarang	Cikarang-Sekasi	Sekasi - Jakarta	Jatiluhur Reservoir	Cibeet	Cikarang	Kali Sekasi
Temperature		°C	30	30	30	30	30	29	29	29
Colour		Unit PtCo	17	24	28	19	12	23	20	17
Turbidity		mg/l SiO_2	78	176	142	103	14	86	126	65
Dissolved solids		mg/l	105	119	112	104	107	128	116	112
Suspended solids		mg/l	118	459	326	160	26	285	298	94
Total solids		mg/l	196	635	468	264	123	371	414	159
Conductivity		µmho/cm	155	168	152	153	145	187	169	156
pH			7.8	7.6	7.5	7.5	8.3	7.6	7.7	7.5
Calcium	Ca	mg/l	16.0	19.7	20.3	19.9	16.1	21.6	21.1	19.4
Magnesium	Mg	mg/l	5.5	5.5	4.6	3.5	4.6	5.6	5.3	4.5
Sodium	Na	mg/l	6.3	7.1	5.4	7.5	6.3	7.2	5.5	4.5
Potassium	K	mg/l	2.4	2.4	1.9	4.4	2.3	2.3	1.7	1.3
Iron	Fe	mg/l	1.1	2.5	1.7	1.3	0.3	1.4	1.5	0.9
Manganese	Mn	mg/l	0.07	0.20	0.13	0.11	0.03	0.19	0.14	0.06
Ammonia	NH_4	mg/l	0.20	0.16	0.15	0.29	0.32	0.26	0.23	0.27
Bicarbonate	HCO_3	mg/l	72.2	79.7	77.3	72.9	73.6	87.9	85.1	71.3
Chloride	Cl	mg/l	7.5	7.3	7.1	5.4	5.2	6.1	5.0	7.5
Sulphate	SO_4	mg/l	8.3	11.3	3.1	3.7	5.3	10.8	8.0	9.5
Nitrate	NO_3	mg/l	0.033	0.17	0.25	0.18	0.26	0.19	0.28	0.21
Nitrite	NO_2	mg/l	0.004	0.004	0.002	0.008	0.002	0.003	0.004	0.005
Fluoride	F	mg/l	0.06	0.04	0.01	0.012	0.04	0.02	0.016	0.07
Carbondioxide	CO_2	mg/l	3.6	3.9	4.5	3.4	2.5	4.8	4.3	3.5
Arsenic	As	mg/l	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Cadmium	Cd	mg/l	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Chrom (VI)	Cr	mg/l	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Copper	Co	mg/l	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Mercury	Hg	mg/l	< 0.0006	< 0.0006	< 0.0005	< 0.0006	< 0.0005	< 0.0006	< 0.0006	< 0.0006
Nickel	Ni	mg/l	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Lead	Pb	mg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Zinc	Zn	mg/l	0.13	0.12	0.10	0.14	0.08	0.09	0.09	0.05
Organic Matter		mg/l $KMnO_4$	8.2	12.3	11.9	11.5	4.7	11.4	9.4	8.3
BOD (20°C-5d)		mg/l	1.1	1.2	1.5	1.5	0.8	1.6	1.4	1.2
Dissolved Oxygen		mg/l	6.4	6.5	6.9	6.1	7.5	6.7	6.9	6.9
Faecal Coli (44.5°C)		MPN/100 ml	$1.7x10^4$	$1.1x10^5$	$6.7x10^4$	$1.6x10^5$	135	$1.5x10^5$	$5.8x10^4$	$6.0x10^4$

Note : Quoted from "Study of Cibeet Irrigation Flood Control and Water Supply Volume 6" by NEDECO.

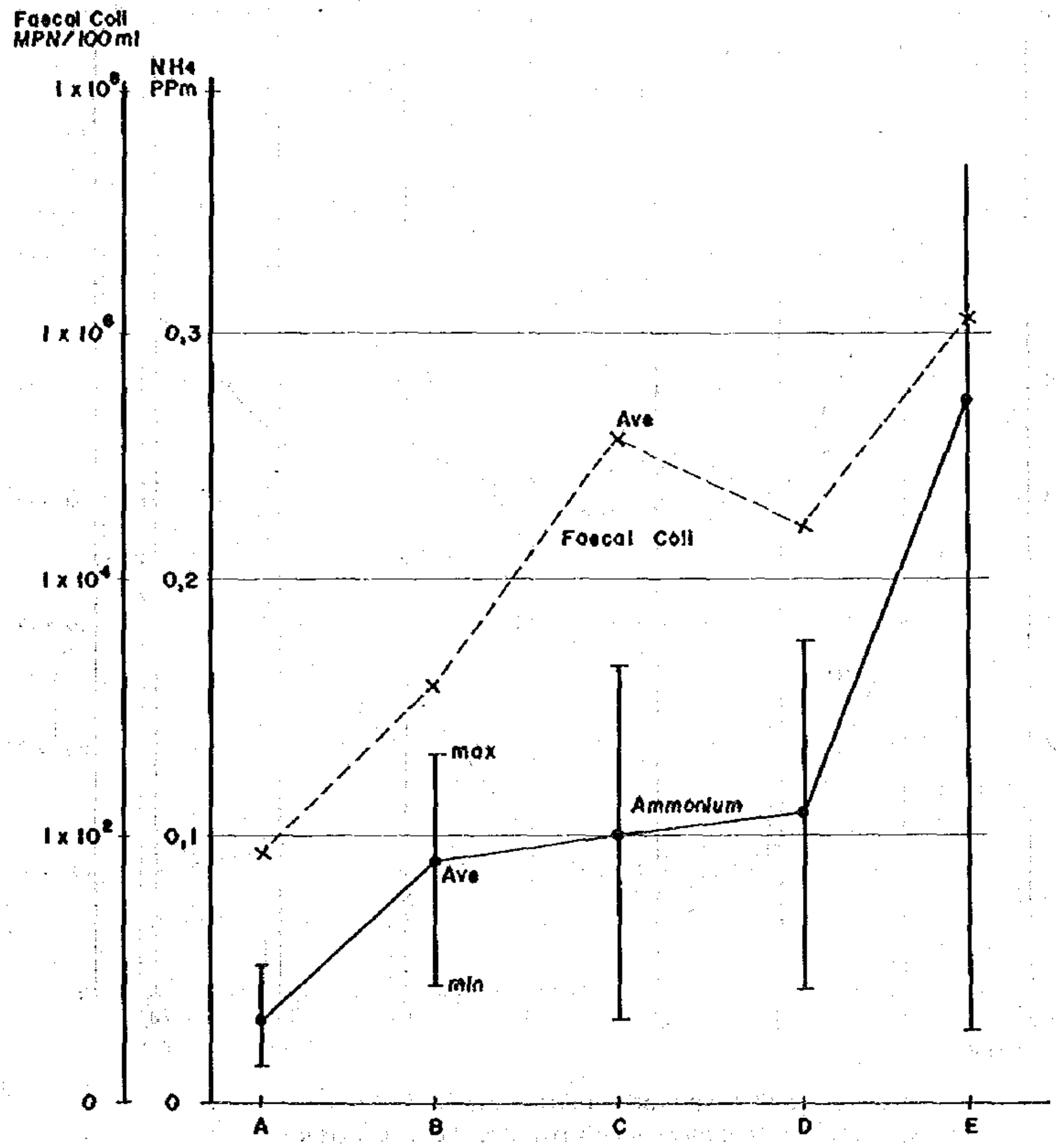
Table 6 Water Quality on the West Tarum Canal

Sampling Point	Date	PH	SS	Organic Matter	BOD	COD	NH4	Feacial Coli
			PPm	PPm	PPm	PPm	PPm	MPN/100ml
2 Km before from Cipinang	10th Aug'81	7.4	130	12.6	2.9	7.1	0.45	-
	13th Aug'81	7.35	131	13.0	2.0	5.6	0.35	-
	25th Aug'81	7.45	106	12.9	3.6	8.8	0.30	-
	15th Oct'81	7.75	100	13.2	1.41	-	0.39	4.3×10^6
	17th Mar'82	7.2	124	7.2	1.4	-	0.69	2.3×10^5
	15th Apr'82	7.8	2480	26.0	2.5	-	0.37	1.1×10^5
	24th Apr.82	7.0	120	9.4	21.4	25.9	-	4.7×10^4
	21st May'82	7.1	68	6.1	0.2	-	0.16	1.5×10^5
5 Km after from Bekasi	10th Aug'81	7.4	147	12.4	2.2	6.4	0.45	-
	13th Aug'81	7.4	90	12.9	2.9	6.2	0.35	-
	25th Aug'81	7.45	104	13.7	2.8	8.4	0.40	-
1 Km before from Bekasi	10th Aug'81	7.45	58	11.9	2.8	7.8	0.50	-
	13th Aug'81	7.35	71.	13.4	7.1	10.7	0.40	-
	25th Aug'81	7.50	104	13.0	2.2	6.3	0.35	-
	15th Oct'81	7.70	80	11.3	1.9	-	0.36	2.0×10^5

Note : Quoted from report of "Study of Cebeet Irrigation Flood Control and Water Supply Volum 10"

Fig. 9 WATER QUALITY ON JATILUHUR DAM AND W T C

(BY PDMA, BANDUNG)

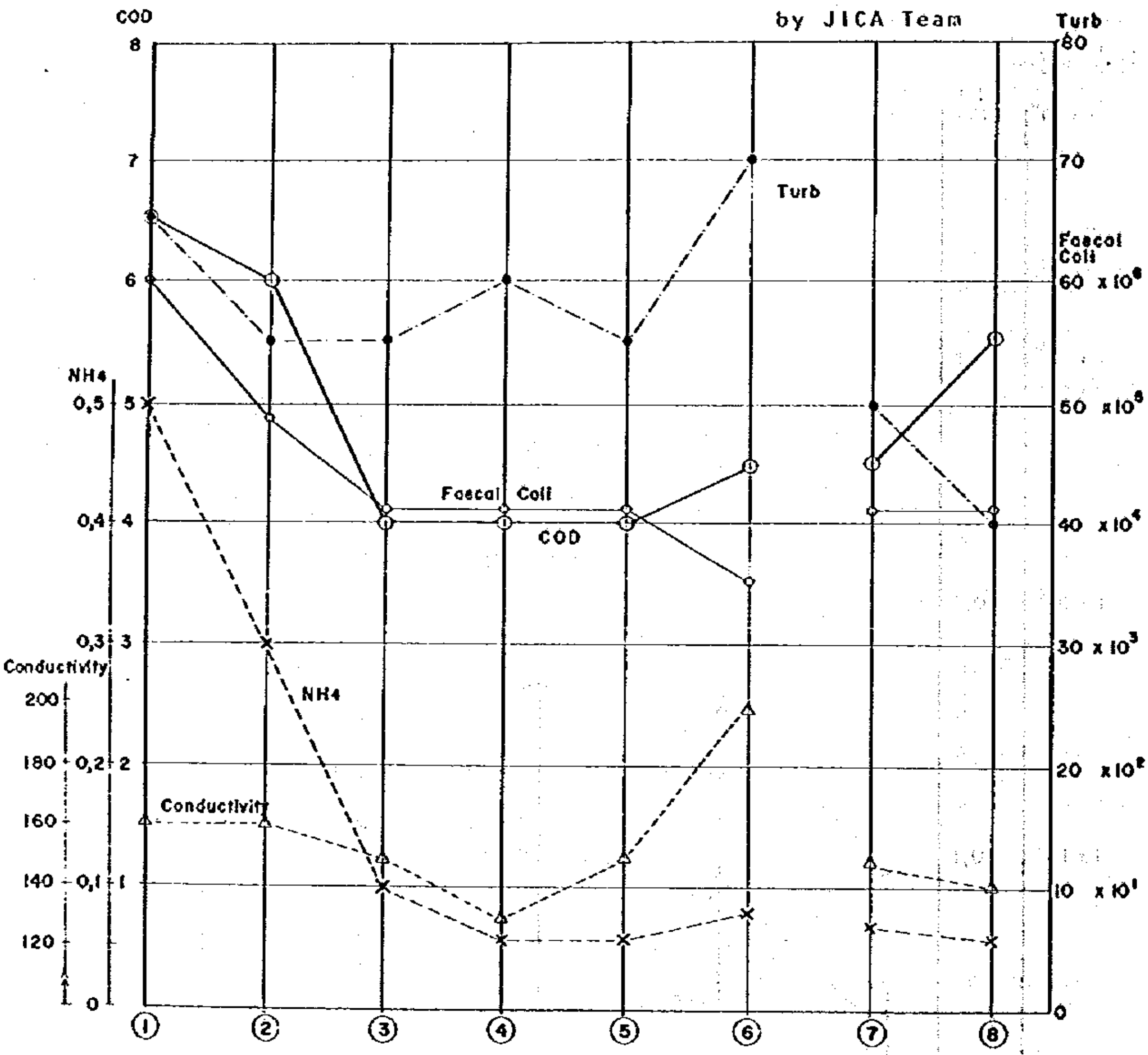


NOTE :

A ; JATILUHUR DAM
B ; WTC (CURUG - CIBEET)
C : WTC (CIBEET - CIKARANG)
D : WTC (CIKARANG - BEKASI)
E : WTC (BEKASI - CIPINANG)

DATA ON 1980 (DAM) AND 1982 (WTC)

Fig. 10 WATER QUALITY ALONG THE WEST TARUM CANAL



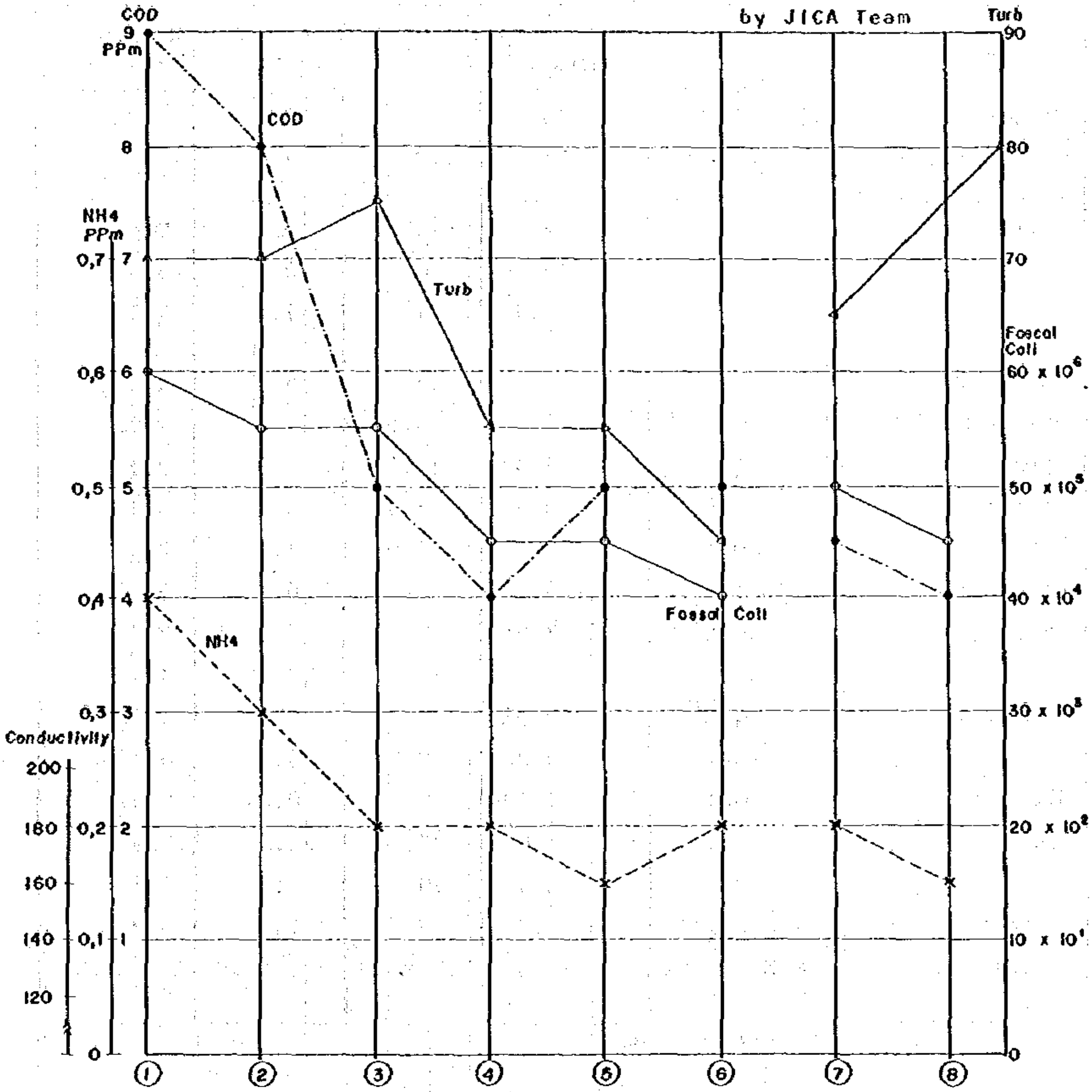
NOTE :

① CROSSING POINT WITH THE CIPINANG RIVER
② JUST BEFURE CROSSING POINT WITH THE SUNTER RIVER
③ CROSSING POINT WITH THE BUARAN RIVER
④ CROSSING POINT WITH THE CAPUNG RIVER
⑤ JUST AFTER CROSSING POINT WITH THE BEKASI RIVER
⑥ JUST BEFORE CROSSING POINT WITH THE BEKASI RIVER
⑦ BEKASI RIVER JUST BEFORE JOINT POINT
⑧ BEKASI RIVER 4Km UPSTREAM FROM JOINT POINT

SAMPLING : 12 JULY 1983

Fig. 11 WATER QUALITY ALONG THE WEST TARUM CANAL

by JICA Team



NOTE :

① CROSSING POINT WITH THE CIPINANG RIVER
② JUST BEFORE CROSSING POINT WITH THE SUNTER RIVER
③ CROSSING POINT WITH THE BUARAN RIVER
④ CROSSING POINT WITH THE CAPUNG RIVER
⑤ JUST AFTER CROSSING POINT WITH THE BEKASI RIVER
⑥ JUST BEFORE CROSSING POINT WITH THE BEKASI RIVER
⑦ BEKASI RIVER JUST BEFORE JOINT POINT
⑧ BEKASI RIVER 4 Km UPSTREAM FROM JOINT POINT

SAMPLING : 25 AUGUST. 1983

Table 8 Quality of Ciliwung River at Manggarai (by DPMA)

Parameter	Unit	Range Minimum	Range Maximum	Average Value	Standard Deviation
Temperature	^{o}C	26	30	28	1.06
Conductivity	μmho/cm	74	128	97.5	27.4
Total suspended solids	mg/l	32	676	208	163
Transparency	cm	10	30	20.4	14.3
pH	-	6.4	7.9	7.4	0.34
Alkalinity (as $CaCO_3$)	mg/l	20	49	35	8
Dissolved Oxygen	mg/l	2.0	6.5	4.5	1.05
Calcium	mg/l	6.4	14.0	9.8	2.0
Magnesium	mg/l	0.9	5.4	3.0	2.0
Iron	mg/l	0.2	11 0	1.9	2.5
Manganese	mg/l	0.04	0.5	0.14	0.18
Chloride	mg/l	3.9	15	8.6	2.2
Sulphate	mg/l	0.1	11	4.4	4.1
Ammonium	mg/l	0.01	1.0	0.13	0.28
Nitrate	mg/l	0.03	2.0	0.6	0.46
Nitrite	mg/l	0.004	0.16	0.04	0.07
COD	mg/l	5.0	97	21.5	22.6
BOD	mg/l	2.0	20	9.3	5.3
Organic Matter	mg$KMnO_4$/l	1.7	22	7.2	5.9
Faecal Coli	MPN/100 ml	7.5×10^5	7.5×10^8	6.3×10^7	1.5×10^7

Note : 27 samples in 1979 to 1980

Table 9 " Data of River Water of the Sunter and the Cipinang "

Name of River		Sunter					Cipinang					
Sampling Point		Before joint with Cipinang					Before diverted from the West Tarum Canal					
	Date	15/4/1971	12/12/1975	13/1/1982 to 6/3/1982	15/6/1983	24/6/1983	15/9/71	10/12/75	1970-1975	9/4/82	15/6/83	24/6/83
Items	Unit											
PH		7.1	6.8		6.8	7.1	7.0	7.1		7.3	7.0	6.9
Turbidity	PPm SiO2	117	140		23	100	61	70		80	225	75
C o l o r	Unit	330	160		-	120	250	50		150	-	400
Organic Matter	PPm KMnO4	15.2	14.2	13.0	10.3	18	10.7	6.3	14.1	61.3	26.5	51
M-Alkalinity	PPm	30	-	-	-	140	40	65		405.	-	290
Ammonium	PPm NH4	Meg	0.6	0.5	0.7	1.6	0.05	1.3	3.1	3.5	3.1	4.5
Chloride	PPm Cl	13			20	15	14			66	-	58
Detergent	PPm				0.02							0.31
Dissolved Oxygen	PPm			8.2	5.3	4.0				0	2.6	0
B O D	PPm				22	25			400		28	70
Faecal Coli	MPN/100 ml				1.3 X 10^7	7 1 X 10^6					1.3 X 10^7	4 X 10^5
I r o n	PPm Fe				0.51	0.9		0.25		Trc	0.57	2.1
Manganese	PPm Mn				0.15	0.5					0.35	0.8
Z i n c	PPm Zn					0.03						0.02
		(1)	(2)	(3)	(4)	(5)	(1)	(2)	(6)	(7)	(4)	(5)

Note : (1) : "Extension project of Jakarta Water Supply System" by Nihon Suido Consultants
(2) : "Raw water Quality and Chemical Application for Design of Pulogadung Water Treatment Plant" by Cipta Karya
(3) : By PDAM - DKI
(4) : By Cipta Karya
(5) : By JICA Study Team
(6) : By Nihon Suido Consultants
(7) : By PDAM - DKI

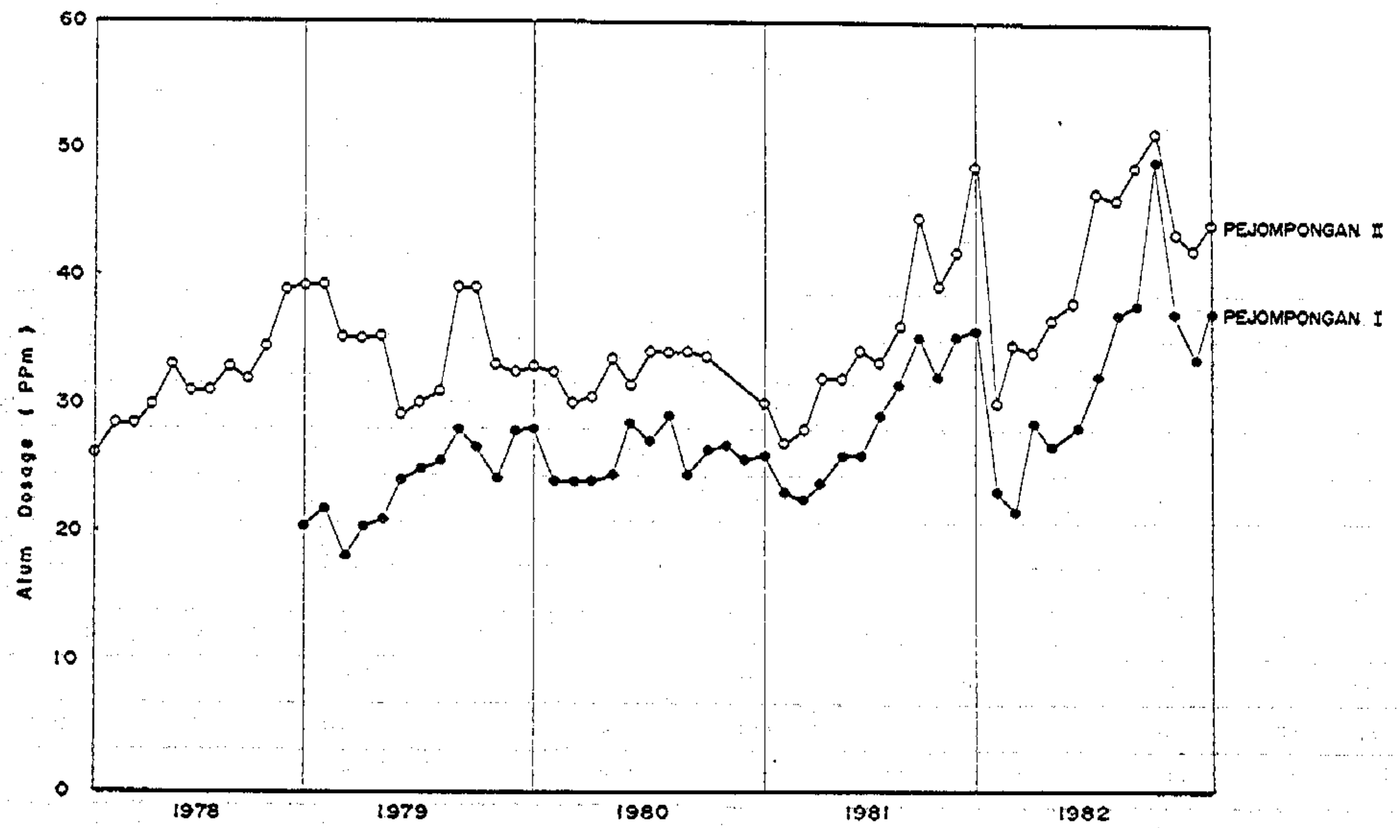


Fig. 12 ALUM DOSAGE OF THE PEJOMPONGAN PLANTS (I AND II)

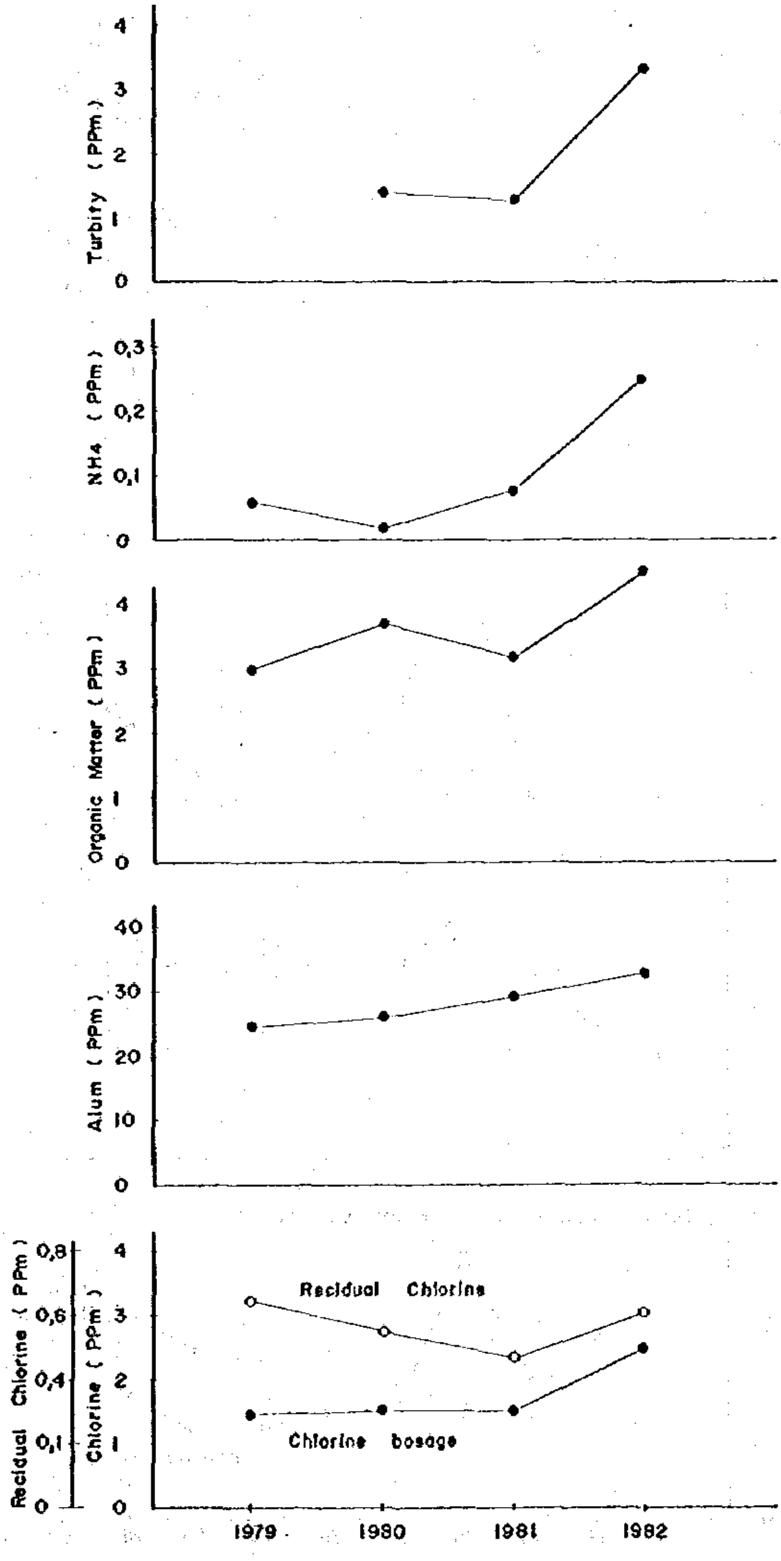


Fig. 13 ANNUAL FLUCTUATIONS OF CLEAR WATER QUALITY AND CHEMICAL DOSAGE AT PEJOMPONGAN I (BY PAM)

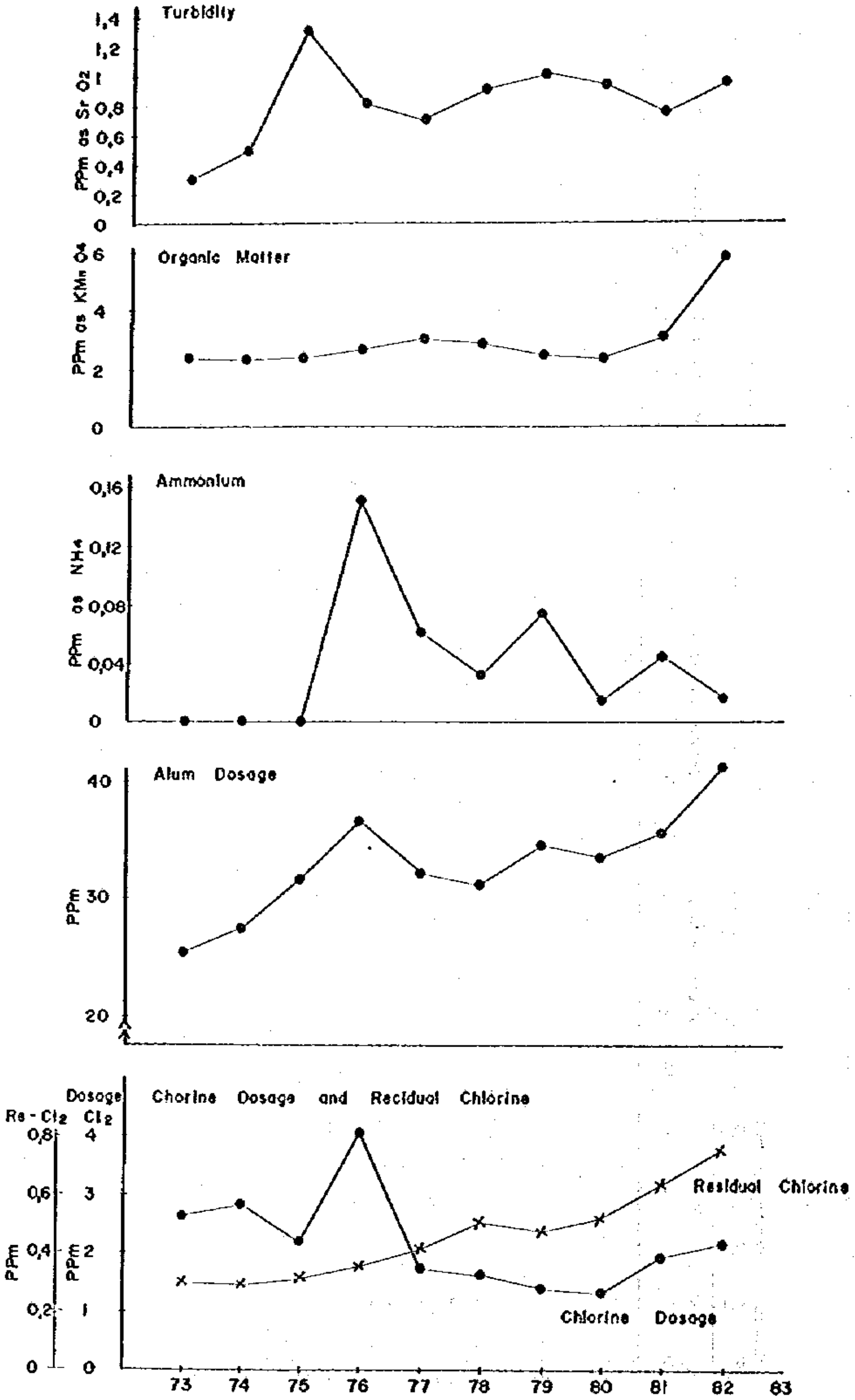


Fig. 14 ANNUAL FLUCTUATIONS OF CLEAR WATER QUALITY AND CHEMICAL DOSAGE AT PEJOMPONGAN II (BY PAM)

Table 12 Chemical Applications of the Pulogadung

YEAR	Month	Alum (ppm)	Chlorine Pre (ppm)	Chlorine Intermadiate (ppm)	Chlorine Post (ppm)	Lime Pre (ppm)	Lime Post (ppm)	Activited Carbon (ppm)
1982	6	70	3	0	4	10	11	0
	7	90	5	0	4	10	5	1.6
	8	72	7	2	1	0	11	1.0
	9	75	4	3	3	0	11	2.8
	10	65	4	2	4	0	13	2.0
	11	60	3	2	3	0	0	2.5
	12	46	2	2	2	0	16	0
1983	1	47	0	0	3.2	0	13	0
	2	42	0	0	3.1	0	10.7	0
	3	46	0	0	2.6	0	8.9	0
	4	45	2	0	1.5	0	11.7	0
	5	37	1	0	2.7	0	18.6	0
	Average	57.9	2.6	0.9	2.[illegible]	1.7	10.8	0.8
	Maximum	90	7	3	4	10	13.7	2.8
	[illegible]	37	0	0	1	0	0	0

TABLE 13

Number of Positive Coliform in Treated Water

PLANTS	YEAR / MONTH	1981 / 1	2	3	4	5	6	7	8	9	10	11	12	(TOTAL)	(%)
PEJOMPONGAN I		0/14※	2/11	0/14	0/13	0/14	2/11	3/9	5/10	1/10	4/12	4/11	7/11	28/40	20
PEJOMPONGAN II		0/14	0/11	0/14	0/13	2/14	1/11	3/9	2/10	1/10	0/12	2/11	4/11	15/40	11
CILANDAK		0/1	-	0/1	0/1	0/1	1/1	0/1	0/1		0/1	0/1	0/1	1/10	
BOGOR		0/1	1/1	0/1	0/1	1/1	1/1	0/1	1/1	1/1	0/1	1/1	1/1	7/12	
PESING					0/1	1/1	0/1	0/1	-	-	1/1	1/1	1/1	3/2	
TOTAL		0/30	3/23	0/30	0/29	4/31	5/25	6/21	8/22	3/21	5/27	8/25	13/25	54/309	
Percentage (%)		0	13	0	0	13	20	28.5	36.4	14	18.5	32	52	17.5	

PLANTS	YEAR / MONTH	1982 / 1	2	3	4	5	6	7	8	9	10	11	12	(TOTAL)	
PEJOMPONGAN I		1/12	0/10	1/12	0/11	1/10	6/11	5/11		6/12	2/12	4/12		26/113	23
PEJOMPONGAN II		0/12	0/10	0/12	0/11	2/10	3/11	1/11		0/12	1/12	1/12		8/113	7
CILANDAK		0/1	0/1	0/1	0/1	0/1	0/1	0/1		0/1	1/1	0/1		1/10	
BOGOR		1/1	1/1	1/1	1/1	1/1	1/1	1/1		1/1	0/1	0/1		8/10	
PESING		0/1	0/1	0/1	0/1	0/1	-	0/1		1/1	-	-		1/7	
Pulogadung							0/3	0/3		0/4	0/4	0/4		0/18	
MUARA KARANG							0/4	0/1		0/2	0/2	0/3		0/12	
CAKUNG							0/4	0/1		0/2	1/4	1/4		2/15	
SUNTER											2/3	1/1		3/4	
TAMAN KOTA											1/1	0/2		1/3	
TOTAL:		2/17	1/23	2/27	1/25	4/23	10/35	7/30		8/35	8/40	7/40		50/305	
Percentage (%)		7.4	4.3	7.4	4	17	28.6	23		23	20	17.5		16.4	

Note : Residual chlorine was found in most of samples taken from treated water of plants except Bogor water where none was found in 16 samples.

※ 0/0 : Figure in left shows positive number of coliform and right shows number of samples

Table 15 Clear Water Quality of the Pulogadung

Month 1982	Color	Turbi- dity	PH	M-Alkali- nity	Hardness	Organic Matter	Iron
5	5 - 10	0.8	6.8	45.4	2.5	10.2	Neg
6	5 - 10	0.55	6.8	89.7	3.8	9.95	Neg
7	5 - 10	0.95	6.8	98.7	5.2	12.0	Neg
8	-	1.5	6.9	99	4.8	8.20	Trc
9	5 - 10	1.6.	7.1	107	5.2	9.04	Neg
10	5 - 10	1.6	6.8	104	4.8	8.95	Neg
11	5 - 10	1.7	6.7	85	4.6	7.32	Neg
12	10 - 15	1.8	7.2	61.2	3.9	4.90	Neg
1983							
1	5	2.3	7.2	54.2	3.9	4.3	Trc
2	5 - 10	2.9	7.0	53.6	3.9	3.75	Trc
3	5 - 10	1.3	7.2	45.1	5.0	3.36	Neg
4	5 - 10	1.6	7.1	51.5	4.7	6.0	Trc
5	5 - 10	1.87	7.1	51.5	3.4	3.84	Neg
Ave.	5 - 10	1.64	7.0	75.2	4.4	6.84	Neg

Table 16 SUMMARY OF THE MINI PLANTS

PLANT	LOCATION	WATER SOURCE	RATED CAPACITY (l/sec)	RAW WATER QUALITY			CHEMICAL APPLICATIONS				TREATEMENT CONDITIONS
				AMMONIUM (ppm)	ORGANIC MATTER (ppm)	DISSOLVED OXYGEN (ppm)	CHLORIDE (ppm)	ALUM (ppm)	CHLORINE (ppm)	ACTIVATED CARBON (ppm)	
Cilandak	South JKT	Krukut R.	200	neg/neg	6.9/6.8	9.9/7.5	7.7/6.45	19.8/17	1.6/0.6 x	0	Desirable
Pejaten	South JKT	Ciliwung R.	5	trc/trc	20/8.3	10.5/7.3	17.8/10.2	44/38	4.1/3.6	-	Desirable
Cakung	East JKT	Irrigation Canal	25	70.6/-	26/9.9	105/7.0	112/14.9	78/52	5.2/2.0		Sometimes Undesirable
Pesing	North JKT	Mokervaart Canal	5	70.6/-	25/12.3	-	510/62	74/55	3.7/2.8	2/-	Undesirable
Muara Karang	North JKT	Banjir Canal	100	1.53/0.59	33.5/15	-	108/26	90/50	12.8/7.0	12/-	Undesirable
Cengkareng	North JKT	Angke R.	50	70.6/-	101/11.5	10.5/7.0	22.7/11.2	49/35	2.9/2.3	1/-	Sometimes Undesirable
Sunter	North JKT	Sunter R.	50	70.6/70.6	37.6/16.2	12/5.3	117/24.8	76/60	7.3/5.0		Undesirable

= maximum / average

Table 17 Chemical Applications of Mini Plants (PPM)

1981

Plant	Items	1	2	3	4	5	6	7	8	9	10	11	12
Cilandak	Alum	19,2	17,7	16,8	18	17,4	18	12,0	15	17,3	24,1	16	16,8
	Chlorine	0,66	0,70	0,65	0,65	0,66	0,83	0,66	0,6	1,32	0,73	0,6	0,6
	Soda Ask	10,7	10,6	18,4	20,5	7,6	28,8	20,6	11	9,5	11,2	10,4	10,8
Pesing	Alum	26	24	31	26	38	37	30	33	33	33	40	52
	Chlorine	1,2	1,6	1,8	2,0	1,5	1,5	1,2	2,3	3,2	1,7	2,3	2,5
	Soda Ask	22	21	30	25	50	45	22	24	22	43	23	48
Buaya Karang	Alum												
	Chlorine												
	Soda Ask												
Kung	Alum												
	Chlorine												
	Soda Ask												
Sunter	Alum												
	Chlorine												
	Soda Ask												
Taman Kota	Alum												
	Chlorine												
	Soda Ask												
Pejaten	Alum												
	Chlorine												
	Soda Ask												

1982

Plant	Items	1	2	3	4	5	6	7	8	9	10	11	12
Cilandak	Alum	17,7	16	15,7	16,9	15,7	15,7	17,2	15,8	17,7	16,6	17,3	18
	Chlorine	0,61	0,62	0,62	0,61	0,62	0,48	0,69	0,51	1,61	0,81	0,5	0,74
	Soda Ask	11,4	11	7,3	6,9	7,0	9,0	9,7	9,7	10,5	9,4	9,4	7,1
Pesing	Alum	55	50	53	52	50	46	43	57	-	-	-	74
	Chlorine	2,5	2,9	2,8	2,2	2,5	2,3	2,0	3,7	-	-	-	3,0
	Soda Ask	44	44	45	44	45	44	41	47	-	-	-	69
Buaya Karang	Alum							59	72	90	63	55	41
	Chlorine							4,9	8,1	9,2	33	4,9	4,5
	Soda Ask							20	21	25	-	21	18
Kung	Alum							45	40	40	45	45	53
	Chlorine							2,6	1,7	1,7	1,3	1,0	1,2
	Soda Ask							15	10	15	-	10	10
Sunter	Alum											76	60
	Chlorine											-	7,3
	Soda Ask										12,0	18	10
Taman Kota	Alum											47	49
	Chlorine											2,1	2,9
	Soda Ask											38	60
Pejaten	Alum												40
	Chlorine												2,5
	Soda Ask												10

1983

Plant	Items	1	2	3	4
Cilandak	Alum	17,8	18,8	19,8	16
	Chlorine	0,64	0,4	0,43	0,49
	Soda Ask	11,4	5,7	9,2	6,5
Pesing	Alum	48	56	49	52
	Chlorine	2,8	2,3	2,6	0,6
	Soda Ask	47	42	43	42
Buaya Karang	Alum	33	31	37	28
	Chlorine	4,9	4,5	4,8	5,0
	Soda Ask	18	21	19	19
Kung	Alum	53	78	50	52
	Chlorine	1,2	5,2	0,94	0,8
	Soda Ask	10	2,5	10	10
Sunter	Alum	67	54	51	53
	Chlorine	5,6	4,7	0,5	3,4
	Soda Ask	6	2,6	1,9	2,9
Taman Kota	Alum	[illegible]	25	33	20
	Chlorine	1,8	1,4	2,9	2,9
	Soda Ask	13	11	16	20
Pejaten	Alum	-	44	33	34
	Chlorine	-	4,1	3,4	4
	Soda Ask	-	23	10	17

Table 18 Water Quality And Chemical Dosage of the Cinlandak Mini Plant

(by PAM)

Items	Unit	1982 2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	Ave	Max	Min
(1) Raw Water (Krukut River)																				
PH		6.9	6.9	6.9	6.9	6.9			6.9	6.9	6.9	6.8	6.8	6.9	6.8	6.7	6.8	6.85	6.9	6.7
Color	Unit PtCo	150	150	150	150	150			150	150	150	150	150	150	150	150	150	150	150	150
Conductivity	Umho/cm	100	100	93	119	120			120	97	-	-	-	-	-	-	-			
Turbidity	PPm SiO2	103	92	80	92	90			895	85	97	97	95	110	118	125	122	107	125	80
M-Alkalinity	PPm CaCO3	28	31	28	286	289			283	285	303	28	271	280	28	29	286	286	31	20
T-Hardness	°D	1.5	1.5	1.5	1.6	1.4			1.4	1.3	1.5	1.3	1.4	1.3	1.3	1.4	1.4	1.4	1.6	[illegible]
Chloride	PPm Cl	6.8	6.4	6.6	6.2	6.4			6.4	6.2	5.5	6.4	6.8	7.7	6.5	6.1	6.3	6.45	7.7	5.5
Organic Matter	PPm KMnO4	5.5	6.4	6.5	6.2	5.6			5.2	6.5	6.9	5.5	5.9	8.1	4.5	4.5	5.2	5.9	8.1	4.5
Iron	PPm Fe	Pos	Pos	Pos	Pos	Pos			Pos	Pos	Pos	Pos	Pos	Pos	Pos	Pos	Pos	Pos		
Manganese	PPm Mn	neg	neg	neg	neg	neg			neg	neg	neg	neg	neg	neg	neg	neg	neg	neg	neg	
Ammonium	PPm NH4	neg	neg	neg	neg	neg			neg	neg	neg	neg	neg	neg	neg	neg	neg	neg	neg	
(2) Finished Water																				
PH		7.1	7.3	6.9	7.0	7.0			7.0	7.0	7.0	6.9	6.9	6.9	7.0	6.8	6.8			
Residual Chlorine	PPm	0.3	0.3	0.3	0.3	0.3			0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3			
Color	Unit PtCo	0-5	0-5	0-5	0-5	0-5				0-5	0-5	0-5	095	0-5	0-5	0-5	0-5			
Conductivity	Umho/cm	142	150	140	154	152			152	143	-	-	-	-	-	-	-			
Turbidity	PPm SiO2	0.32	0.43	0.39	0.38	0.37			0.37	0.33	0.49	0.47	0.44	0.5	0.52	0.53	0.50			
M-Alkalinity	PPm CaCO3	30	31,8	31.7	31.9	30.1			30.9	28.5	31.8	26	28.5	30.0	35.5	30.3	29.4			
Organic Matter	PPm KMnO4	2.4	3.7	4.1	7.25	3.7			3.7	3.4	8.3	2.4	3.9	2.9	3.4	3.2	3.2			
(3) Chemical Dosage																				
Alum	PPm	16	15.7	16.9	15.7	15.7	17.2	15.8	17.7	16.6	17.3	18.0	17.8	18.8	19.8	16.0	17.4			
Soda Ash	PPm	11	7.3	6.9	7.0	9.0	9.7	9.7	10.5	9.43	9.4	7.1	11.4	5.7	9.2	6.45	9.2			
Chlorine	PPm	0.62	0.62	0.63	0.62	0.48	0.69	0.51	1.61	0.51	0.5	0.74	0.61	0.4	0.43	0.49	0.48			
(4) Water Quantity																				
Intake	X103m3/Month	429	456	449	465	447	453	438	423	440	341	390	435	404	462	461	460			
Production	X103m3/Month	409	440	436	450	424	401	388	371	395	297	351	414	395	447	428	448			

TABLE 19 WATER QUALITY AND CHEMICAL DOSAGE OF THE MUARA KARANG MINI PLANT

Items	Year / Month / Unit	1982 7	8	9	10	11	12	1983 1	2	3	4	5	6	Ave	Max	Min Tt (1)
(1) Raw Water (Banjir Canal)																
PH		7.0	6.9	7.3	7.0	6.9	6.8	6.8	6.7	6.9	6.8	6.9	6.7	6.9	7.3	6.7
Color	Unit PT Co	-	150	100	150	150	150	150	150	150	150	150	100	150	150	100
Conductivity	umho/cm	-	-	-	-	-	-	-	-	-	-	-	65	-		-
Turbidity	ppm SiO2	-	-	-	-	-	80.4	80.2	49	47.1	45	37.8	40	54	80.4	40
M-Alkalinity	ppm CaCO3	40	62.2	185	91.1	96.2	79	59.5	68.3	70.9	76	79.2	60	81	185	40
T-Hardness	°D	2.8	4.0	7.6	4.0	3.4	3.0	2.5	2.8	2.7	3.0	2.8	2.2	3.4	7.6	2.2
Chloride	ppm Cl	25.5	28.1	108	28.1	23.0	17.1	14.2	13.6	13.4	13.3	12.9	14.2	26	108	129
Organic Matter	ppm KMnO4	-	13.6	33.5	17.2	10.1	14.5	13.7	18.0	13.6	11.1	11.5	6.6	15.0	33.5	66
Iron	ppm Fe	0.25	0.22	1.1	0.76		neg	neg	neg	0.2	neg	neg	1.3	-	1.3	neg
Manganess	ppm Mn	neg	neg	pos	neg	neg	neg	neg	neg	neg	neg	neg	trc	-	pos	neg
Ammonium	ppm NH4	1.5	1.53	0.6	1.4	0.9	0.3	0.2	0.23	0.17	0.12 neg(oxygen)	0.1	trc	0.59	1.53	trc
(2) Finished water																
PH		7.4	7.5		7.3	7.4	7.2	7.2	7.2	7.1	7.1	7.2				
Recidual chlorine	ppm	1.2	1.15		1.3	1.15	1.1	1.25	1.2	1.35	1.4	1.25				
Color	unit Pt Co	5.10	5.10		15.20	5.10	5.10	5.10	0.5	5.10	0.5	5.15				
Iron	ppm Fe	0.10	0.14		neg	neg	neg	neg	neg	neg	0.05	neg				
Turbidity	ppm SiO2	1.14	1.17		1.25	0.97	1.25	1.5	1.5	-	-	1.15				
M-Alkalinity	ppm CaCO3	37.5	47.2		85.5	90.8	66.5	59.5	68.3	66	68	72.1				
Organic Matter	ppm KMnO4		6.7		5.25	4.9	4.81	4.7	5.5	5.5	4.6	4.4				
Ammonium	ppm NH4	0.8	1.24		1.2	0.09	0.25	0.05	0.17	0.05	0.07	0.17				
(3) Chemical Dosage																
Alum	ppm	58.6	72.2	90	63.1	55.1	41.3	32.4	31	37.4	28.4	27.1				
Soda Ash	ppm	20.2	20.5	25	24.9	20.6	18.2	17.6	20	18.9	19.1	16.6				
Chlorine	ppm	4.9	8.1	9.2	12.8	4.93	4.54	4.8	4.4	4.8	5.0	3.73				
Activate carbon	ppm	(3.3)	(2.7)	(12)	(3.7)	0	0	0	0	0	0	0				
(4) Water Quantity																
Intake	$x10^3 m^3$/month	187	154	126	152	147	242	239	219	258	250	254				
Production	$X10^3 m^3$/month	138	127	80	121	117	209	218	202	244	239	238				

TABLE 20 WATER QUALITY AND CHEMICAL DOSAGE OF THE PESING MINI PLANT

Items	Year / Month / Unit	1982 2	3	4	5	6	7	8	9	10	11	12	1983 1	2	3	4	5	6	7	Ave	Max	Min
(1) Raw Water (Angke River)																						
PH		6.9	6.9	6.6	6.5	6.8	-	7.1	7.1	6.3	6.9	6.5	6.6	6.7	6.6	7.6	-	-	6.7	6.8	7.6	6.3
Color	Unit Pt Co		150	150	150	150	-	150	150	150	100	100	150	150	150	100	-	-	100	-	150	100
Conductivity	umho/cm	126	183	124	126	180	-	1720	925(SO_4)		-	-	-	95	120	65	-	-	65	200	1720	65
Turbidity	ppm SiO_2	93.6	95	102	101	102	-	-	25	-	-	-	35	30	-	50	-	-	40	67	102	25
M-Alkalinity	ppm $CaCO_3$	37.6	40.3	30	30.5	36.1	-	140	110	50	110	60	50	55	50	35	-	-	45	59	140	30
T-Hardness	°D	1.6	1.8	1.7	1.6	1.7	-	7.6	114	4.0	2.8	2.2	3.0	2.6	1.8	1.8	-	-	2.8	3.2	11.4	1.6
Chloride	ppm Cl	9.0	9.4	14.2	8.9	-	-	227	510	29.8	21.3	14.2	25	10.1	14	12	-	-	27	62	510	8.9
Organic Mat.	ppm$KMnO_4$	9.8	7.3	9.31	9.5	20.8	-	17.4	25	13.9	16.4	6.3	20	7.6	4.1	2.8	-	-	13.6	12.3	25	2.8
Iron	ppm Fe	pos	pos	pos	pos	-	-	2.0	1.1	4.0	1.5	trc	2.0	3.4	0.65	3.4	-	-	1.0	2.2	3.4	trc
Manganese	ppm Mn	neg	neg	neg	neg	-	-	pos	trc	pos	trc	neg	pos	1.0	nog	1.1	-	-	trc	-	1.1	neg
Ammonium	ppm NH_4	neg	neg	neg	neg	-	-	0,6	1,6	0,45	0,6	neg	trc	0,6	trc	0,25	-	-	trc	-	0,6	neg
(2) Finished water																						
PH		7,1	7,2	6,8	6,8	7,2		7,1	6,5													
Residual Chlorine	ppm	0,2	0,13	0,15	0,1	0,1		0,0	0,0													
Color	Unit Pt Co	0.5	0.5	5.10	5.10	0.5		-	65													
Conductivity	umho/cm	222	256	244	241	325		1350 (So_4)	25													
Turbidity	ppm SiO_2	0.8	0.76	0.8	0.81	0.57		3.4	-													
M-Alkalinity	ppm $CaCO_3$	38.9	43.7	23.6	32.8	39		90	20													
Organic Mat.	ppm	5.8	3.9	7.5	7.7	5.8		6.3	7.3													
							Cl	568	41.2													
							Fe	1.3	3.7													
(3) Chemical Dosage										No Production												
Alum	ppm	49.9	52.6	51.5	50	46.2		42	57			7.4	48	56	49	52	50					
Soda Ash	ppm	43.3	44.9	43.9	54.6	43.8		41	47			.69	47	42	43	42	26					
Chlorine	ppm	2.9	2.75	22	2.5	2.35		20	37			3.0	2.8	2.3	2.6	0.6	28					
(4) Water Quantity																						
Intake	$X10^3$/month	3.0	3.7	3.6	3.64	3.76		3.89	4.28			2.69	2.64	2.86	2.97	3.58	3.40					
Production	$X10^3$/month	2.8	3.5	3.37	3.4	3.52		3.63	4.00			2.50	2.32	2.48	2.39	3.20	3.01					

TABLE 21 Evaluation of Water Sources Based on the Existing Water Quality of Pollution Index in and around the Jakarta City (Short Term Consideration)

Parameters	Ammonium※		Dissolved Oxygen ※		Chloride	
Evaluation	Desirable	Undesirable	Desirable	Undesirable	Desirable	Undesirable
Concentration	Less than 0,5 ppm	More than 0,5 ppm	More than 7 ppm	Less than 5 ppm	Less than 20 ppm	More than 20ppm and Changeable
Name of Water Sources	- Ciburial Spring - Ciliwung R. at Condet Pejaten - Krukut R. at Cilandak - Grogol R. at Pondok Indah - West Tarum C. at Sunter R. - Angke R. at Taman Kota	- Sunter R. at Kelapa Gading - Banjir C at Jembatan Besi - Cipinang R. at Joint Sunter - Banjir C. at Pejompongan - Sunter R. at Pulo Gadung	-Ciliwung R at Condet, Pejaten -Krukut R. at Cilandak -Grogol R. at Pondok Indah -Angke R. at Taman Kota -West Tarum C. at Sunter R. -Cakung R. at Cakung	- Banjir C at Jembatan Besi - Cipinang R. at Joint Sunter - Sunter R. at Pulo Gadung	- Ciburial Spring - Ciliwung R. at Condet Pejaten - Krukut R. at Cilandak - Grogol R. at Pondok Indah - Angke R. at Taman Kota - West Tarum C. at Sunter R. - Cakung R. at Cakung	- Cisadane R. at R.W.Buaya - Angke R. at Pesing - Sunter R. at Kelapagading - Banjir C. at JembatanBesi - Cipinang R. at Joint Sunter

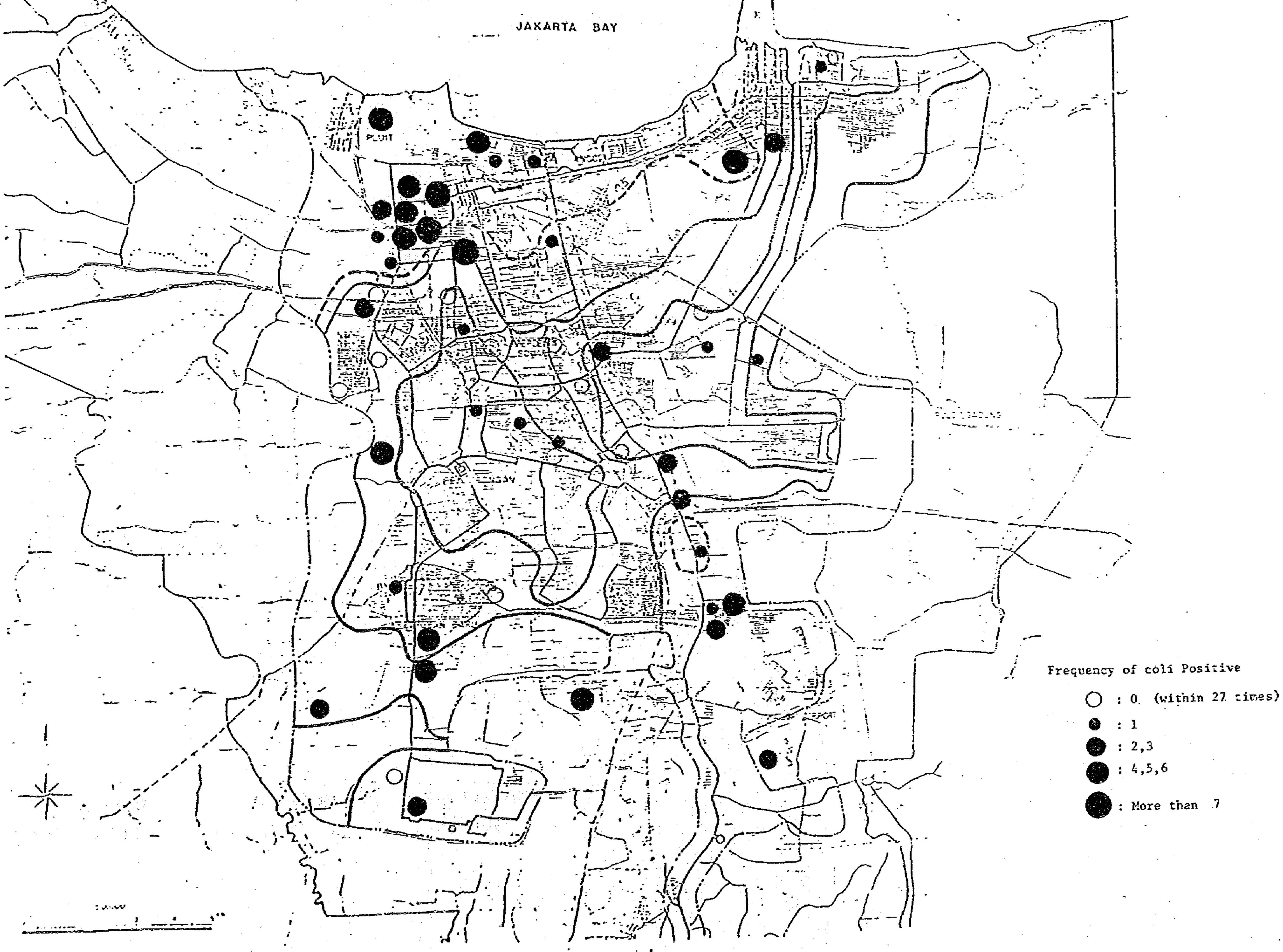
※:Based on the "Raw Water Quality for Drinking Supply Standards by DKI-Jakarta"

Classification of Water Sources	River
1. Desirable Sources	Ciburial Spring, West Tarum Canal at Sunter River, Cakung at Cakung, Ciliwung River at Condet and Pejaten, Krukut River at Cilandak, Grogol River at Pondok Indah, Angke River at Taman Kota
2. Undesirable Sources	Sunter River at Kelapagading and Pulogadung, Cipinang River at Joint Sunter, Banjir Canal at Jembatan Besi and Pejompongan, Angke River at Pesing.

Note: "Desirable Sources" means that the water is able to use for raw water of water works without special treatment".

"Undesirable Sources" means that it is better to give up taking water from its point or the water needs special treatment for making drinking water"

Fig. 16 Distribution of Coliform Positive in Tap Water



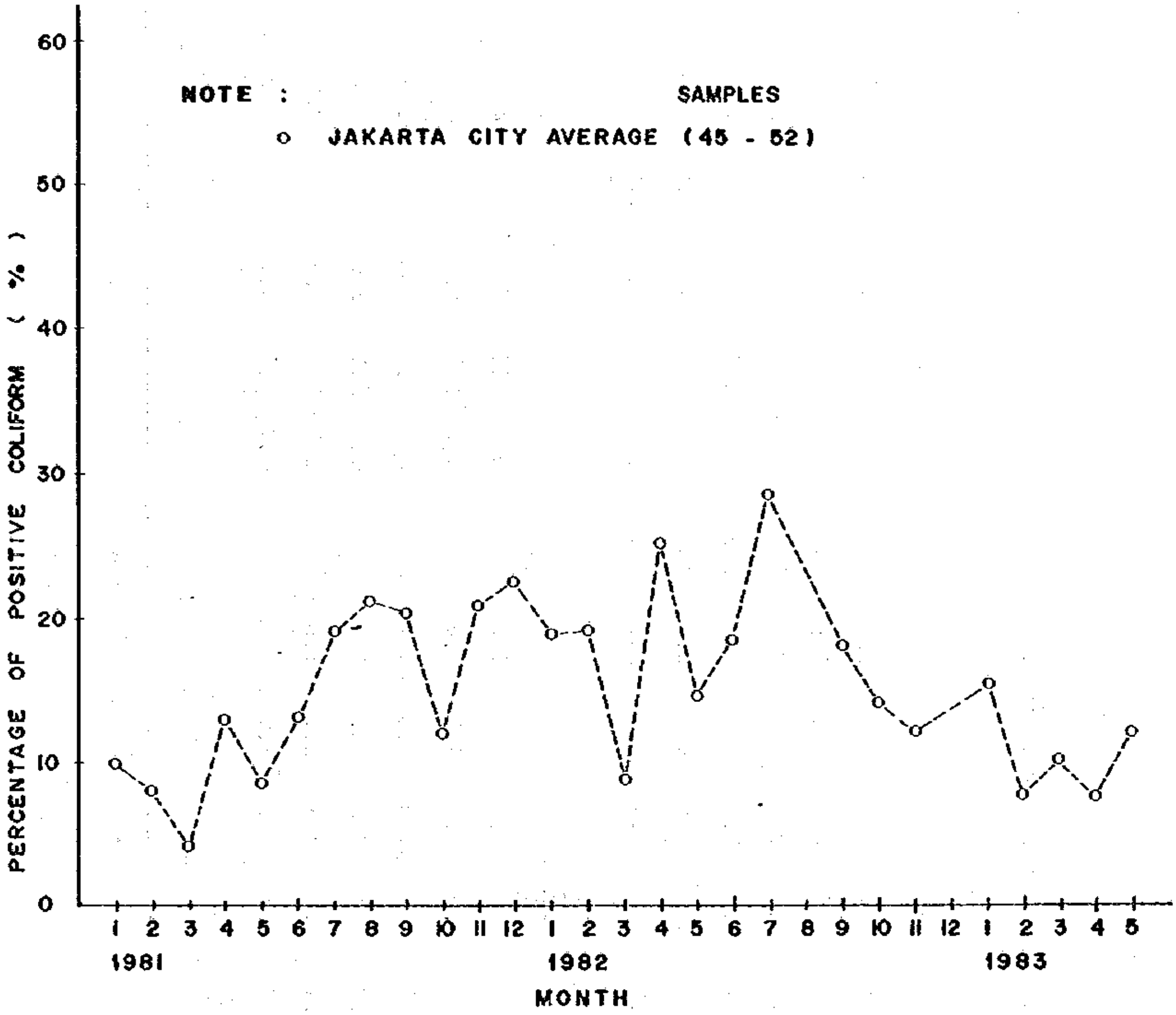


Fig. 17 MONTHLY FLUCTUATION OF PERCENTAGE OF POSITIVE COLIFORM IN TAP WATER

TABLE 22 **Concentration of Organic Matter in Tap Water**

1981 Month													
Distric	1	2	3	4	5	6	7	8	9	10	11	12	average
Central Jakarta	2.3	2.2	3.8	3.1	2.9	1.8	2.0	4.4	5.4	4.1	3.6	5.0	3.4
West Jakarta	1.5	1.8	2.4	3.4	2.8	1.9	4.8	3.2	2.4	3.5	5.8	4.7	3.2
East Jakarta	1.9	2.3	3.0	3.4	2.5	1.7	2.4	1.6	2.1	3.2	1.9	3.2	2.4
North Jakarta	3.0	2.3	2.2	3.8	2.0	2.9	2.7	2.1	3.9	3.1	3.0	2.6	2.8
South Jakarta	2.2	1.6	4.9	2.4	2.9	4.1	2.7	1.9	4.1	3.6	3.5	2.6	3.0
(Average)	2.2	2.0	3.3	3.2	2.7	2.5	2.9	2.6	3.6	3.5	3.6	3.6	3.0
1982													
Central Jakarta	2.0	1.8	3.5	2.9	3.1	4.4	5.8		10.7	4.3	4.4		4.3
West Jakarta	2.4	2.3	2.1	3.0	3.7	4.7	7.4		4.6	5.1	4.7		4.0
East Jakarta	2.6	1.2	2.2	1.7	2.0	2.5	10.5		6.0	5.1	4.8		3.9
North Jakarta	1.9	2.2	3.8	3.7	2.5	4.9	10.0		6.0	5.8	3.6		4.4
South Jakarta	2.2	3.0	2.1	2.3	2.7	2.9	6.6		4.2	3.3	2.5		3.2
(Average)	2.2	2.1	2.7	2.7	2.8	3.9	8.1		6.3	4.7	4.0		4.0

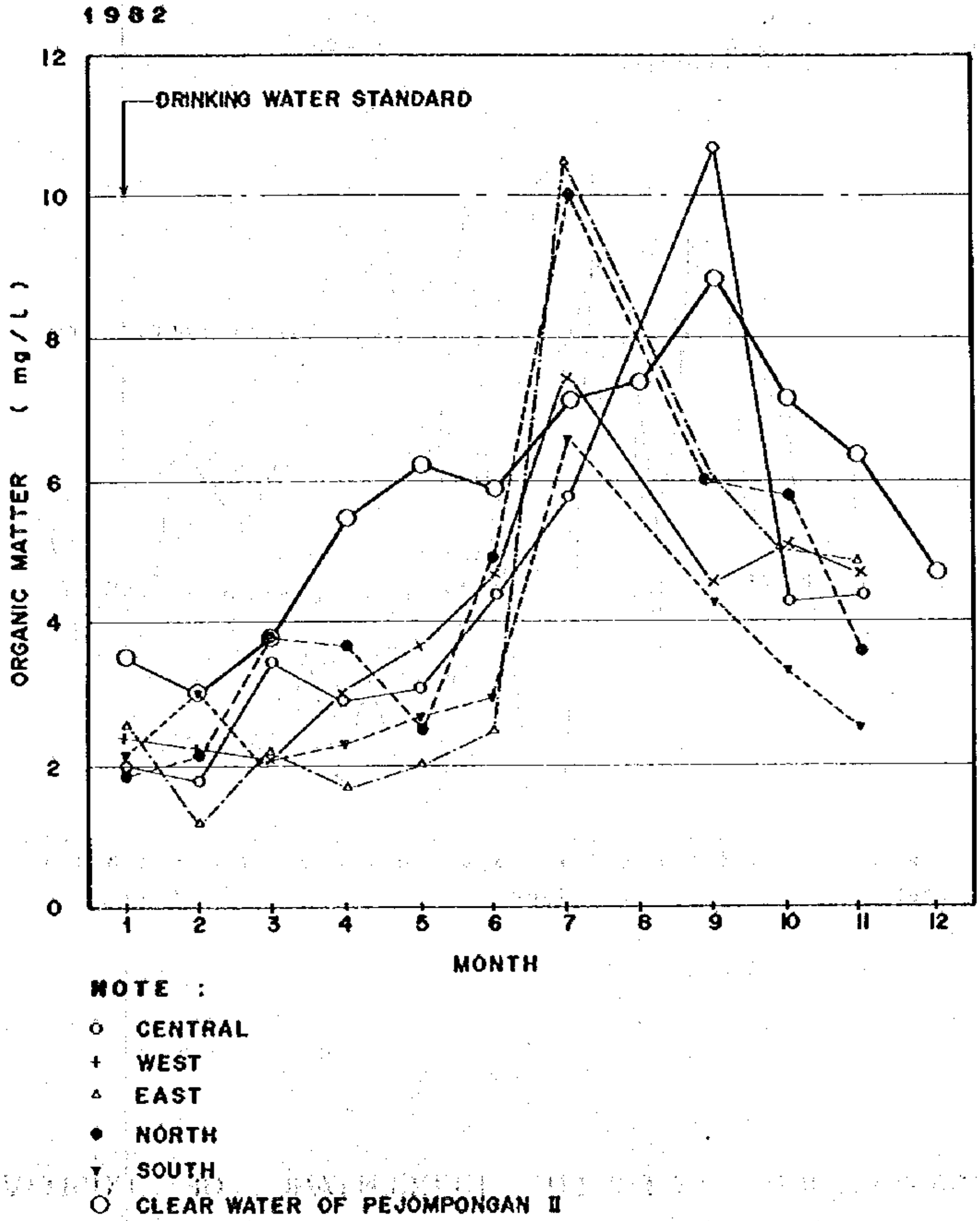


Fig. 18 CONCENTRATION OF ORGANIC MATTER IN TAP WATER

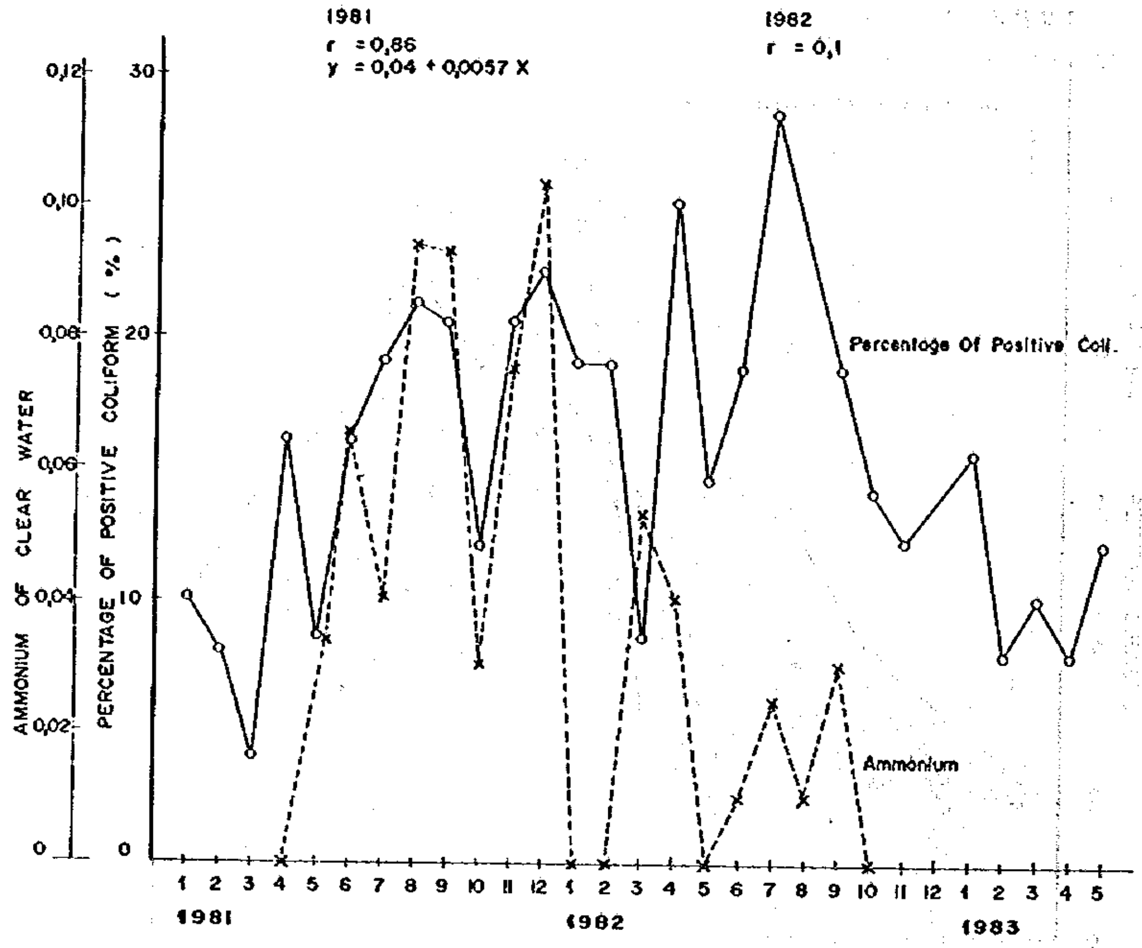


Fig. 19 CORRELATION BETWEEN PERCENTAGE OF POSITIVE COLIFORM IN TAP WATER AND AMMONIUM CONCENTRATION OF CLEAR WATER

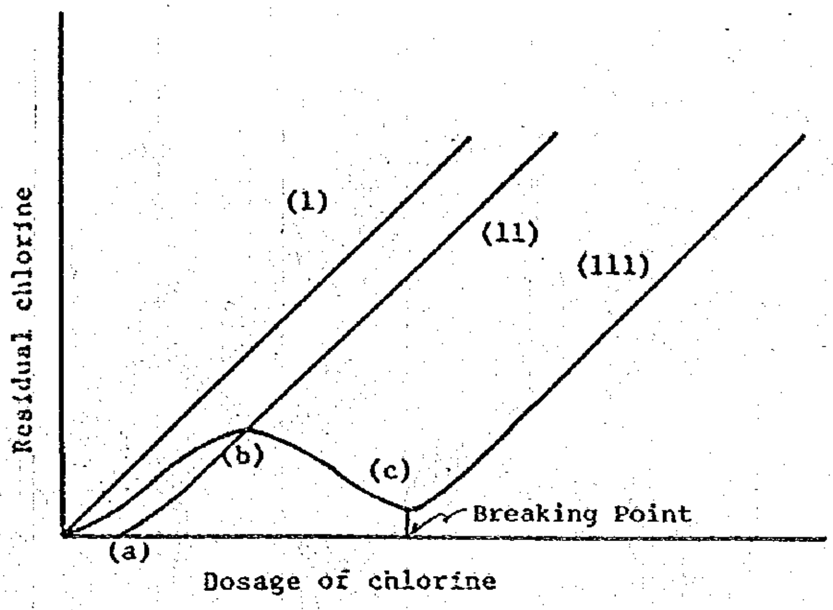


Fig. 20 Reaction pattern of chlorine

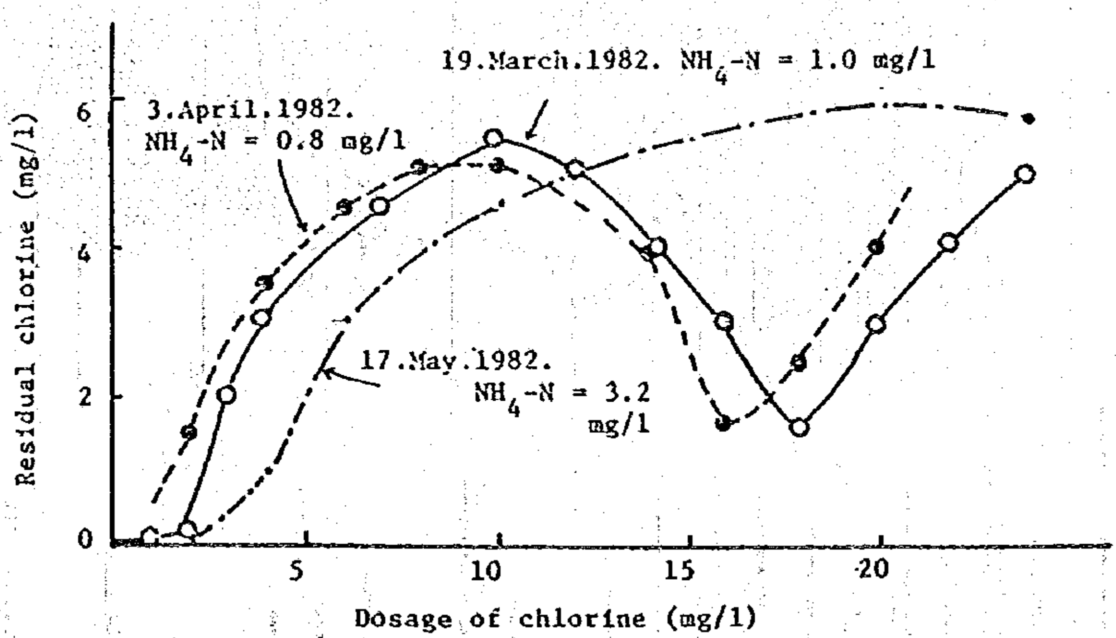


Fig. 21 Chlorine consumption curve at raw water of the Pulogadung quoted from "Guidance of Chemical Treatment for Pulogadung Plant" by Nihon Suido Consultants

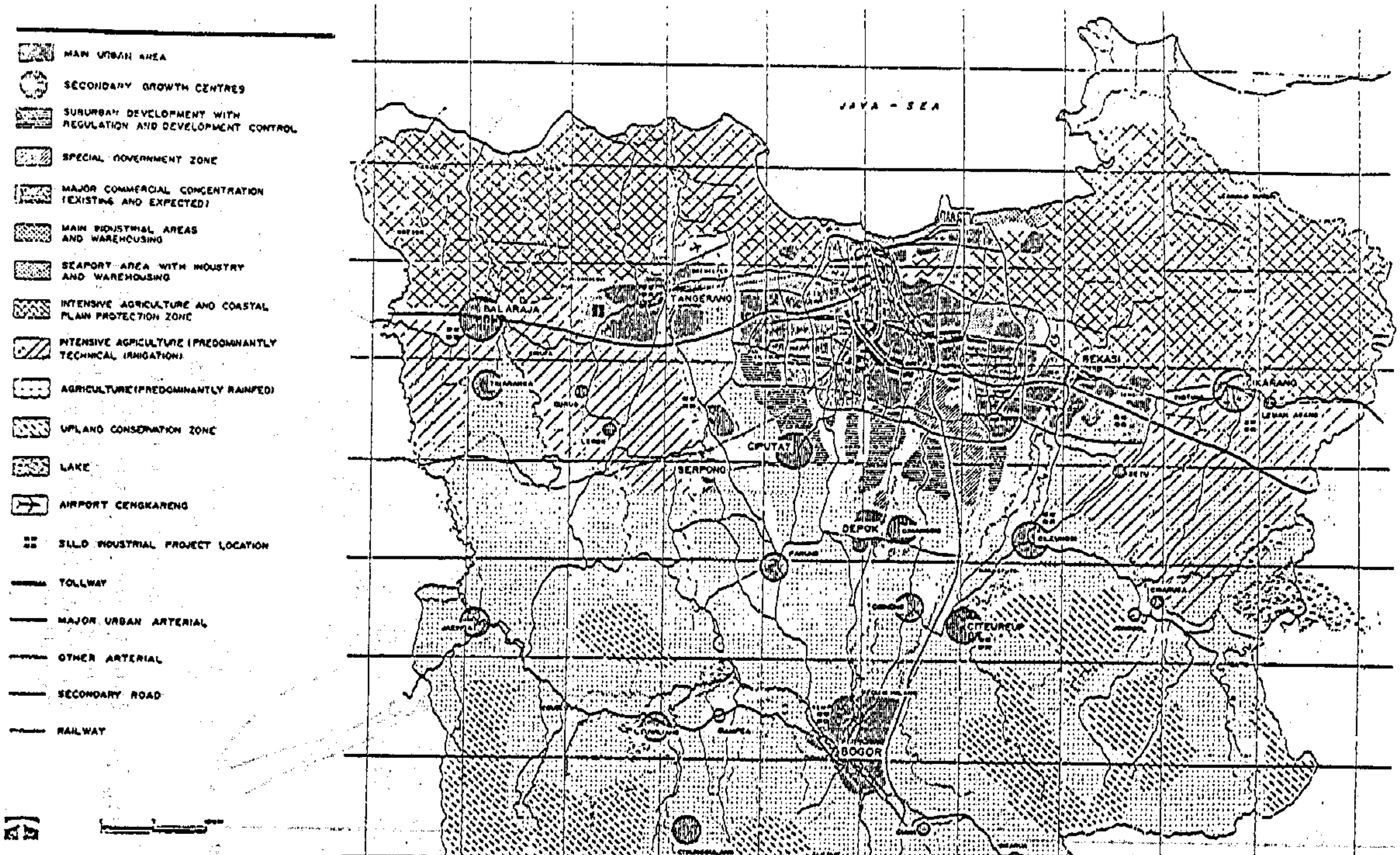


Fig. 22

OUTLINE REGIONAL STRUCTURE FLAN

Table 23 Characteristic of Pretreatment

Treatment Method	Ozon Oxidation	Activated Sldge	Fixed Biological Film Contact Oxidation	Aerated Lagoon
Treated Efficacy				
- Ammonium (NH4)	Non Removal	To be removed	High Efficacy	High Efficacy
- Faecal Coli	High Efficacy	To be removed	High Efficacy	High Efficacy
- Detergent	High Efficacy	To be removed	High Efficacy	High Efficacy
- Dissolved Oxygen (DO)	High Efficacy	High Efficacy	High Efficacy	High Efficacy
- B O D	High Efficacy	High Efficacy	High Efficacy	High Efficacy
- Other Quality Items to be treated	Organic Matters, Odor, and Iron	Organic Matters	Organic Matters,Odor, Color, Iron and Manganese	Organic Matters, Odor Iron and Manganese
Advantages	- more efficacy of disinfection is proved	- more efficacy in sewage system is proved	- Easier operation - No use of chemicals - especially suitable here for water having high water temperature - More efficacy in water-works is proved in Japan	- Easier operation - Lower running cost - No use of chemicals - Suitable for water having high fluc-tuation of polluted quality values
Disadavantages	- Being possibility of Toxic Matters in use of polluted water - More consumption of electricity - Production of colored water by existing Manganese ion - Actiavted Carbon Filter processes is necessary - More than 5 ppm of Ozon dosage would be necessary	- Hard operation - Unknown efficacy of low concentration of polluted water quality - There is no result of pretreatment on water-works - Occurance of foam	- Occurance of foam	- Necessary retention time of 1 to 2 weeks (wide space) - Occurance of foam
Remarks			- Treatment process utilizes biological film	- This process uses aeration and lagoon

Table 24 Treatment Processes and Chemical Applications of Alternative Intake Points

Alternative Intake Points	Treatment Processes	Chemical Applications and their Dosage			
		Necessary Chemical Applications	Dosages (ppm) Max	ave.	Min
	Aeration Chamber	Pre-Chlorine	10	4-5	1
	Transmission	Intermediate-Chlorine	3	1-2	0
a. End of the	Existing Treatment	Post-Chlorine	3	1-2	1
Canal	Facilities	Alum (or PAC) as 17%Al_2O_3	80	30	20
		Polymer (as Zuclur)	0.1	0.03	0
		Pre-lime as 50-70%CaO	12	8	2
		Post-lime	25	15-20	10
b. 2 km east of	(Aeration Chamber*)	Pre-Chlorine	10	5	1
the Sunter	Transmission	Intermediate-Chlorine	3	1-2	0
River	Existing Treatment	Post-Chlorine	3	1-2	1
	Facilities	Alum (or PAC)	80	30	20
	*; be required in	Polymer (as Zuclur)	0.1	0.03	0
	future	Pre-lime	12	8	2
		Post-lime	25	15-20	10
c. Out of	Transmission	Pre-Chlorine	10	4-5	1
Jakarta	Existing Treatment	Intermediate-Chlorine	3	1-2	0
boundary	Facilities	Post-Chlorine	3	1-2	1
		Alum (or PAC)	70	30	20
		Polymer (as Zuclur)	0.1	0.03	0
		Pre-lime	12	8	2
		Post-lime	25	15-20	10

Table 25 Treatment Process and Chemical Applications
(Water of Canal 1 and Cisadane River)

Water	Treatment Process	Chemical Applications	max. (ppm)	ave. (ppm)	min. (ppm)
Canal 1 *1	· Flocculation	Prechlorine	5	3	1
		Postchlorine	4	2	1
	· Horizontal Flow Sedimentation	Alum as 17% Al_2O_3	80	20	15
		Polymer as Zuclur	0.05	0.03	0
	· Rapid Sand Filtration	Pre-lime as 50-70% CaO	10	5	0
		Post-lime	10	5	0
Cisadane River *2	· Flocculation	Prechlorine	5	2	2
	· Horizontal Flow Sedimentation	Postchlorine	3	1-2	1
		Alum (or PAC)	80	20-30	20
	· Rapid Sand Filtration	Pre-lime	13	8	0
		Post-lime	22	15-19	10

Note : *1 : Estimate based on the Jar Test carried out by PDMA and JICA
*2 : Estimate based on the data of the existing plants

Table 26 Coagulation Tests of Jatiluhur Dam Water

Date		24/4'82	14/5'82	25/5'82	3/6/'82			4/8'83		
Raw Water Quality	Unit									
P H		7.5	8.0	7.9	7.1			7.8		
Turbidity	NTU	30.	13.0	14.0	9.0			4.5		
M-Alkalinity	ppm	-	-	-	-			-		
Organic Matter	ppm	5.3	5.3	5.8	4.3			6.0		
B O D	ppm	10.25	5.4	4.0	4.5			-		
C O D	ppm	13.9	6.6	7.0	9.7			-		
Ammonium	ppm	-	-	-	-			0.1		
Suspended Solid	ppm	25	4.7	3.2	3.2			-		
Faecal Coli	MPN/100ml	Neg	320	60	170			500		
Alum Dosage	ppm	35	30	30	30	20	20	20	30	50
Polymer Dosage	ppm	0	0	0	0	0	0.02	0.05	0	0
Treated Water										
P H		6.9	7.3	7.1	6.6	7.5	7.5	7.5	7.3	6.8
Turbidity	NTU	5.0	1.9	1.4	1.7	3.0	1.9	1.1	2.5	4.5
Ammonium	ppm	0.1	0.01	Neg	0.03	-	-	-	-	-

Note : Data of 1982 from Cipta Karya
Data of Aug. 1983 form the JICA Study Team

ATTACHMENTS

Attachment 1. Requirement for Drinking Water in Indnesia

Table 2-12 REQUIREMENT FOR DRINKING WATER

Items		Permissible Value	Non-permissible Value
1. Physical Requirement			
pH		7.0 - 8.5	6.5 - 9.5
Solid matters		500 mg/l	1500 mg/l
Turbidity (Silica unit)		1 "	5 "
Color (Platina Cobalt unit)		5 "	50 "
Taste		non-objectionable	-
Odor		"	-
2. Chemical Requirement			
Lead	Pb	0.5 mg/l	
Selenium	Se	0.05 "	
Arsenic	As	0.2 "	
Chromium (hexavalent)	Cr VI	0.5 "	
Cyanida	C.N.	0.01 "	
Fluor	F	1.0 "	
Nitrite	NO_2	0.001 "	
Nitrate	NO_3	20 "	
Iron	Fe	0.3 "	1.0 mg/l
Manganese	Mn	0.1 "	0.5 "
Copper	Cu	1.0 "	1.5 "
Zinc	Zn	5.0 "	15.0 "
Calcium	Ca	75.0 "	200.0 "
Magnesium	Mg	50.0 "	150.0 "
Sulphate	SO_4	200.0 "	400.0 "
Chlorine	Cl	200.0 "	600.0 "
Sulphate magnesium + Sulphate natrium		500.0 "	1,000.0 "
Phenol		0.001 "	0.002 "
Carbon dioxide, aggresive	CO_2	0 "	10.0 "

3. Bacteriological Requirement

Drinking water must be free from infectious micro-organisms and coliform bacteria. In order to ensure the requirements which are already described, tap water shall be disinfected and periodical and regular bacteriologic test must be made.

Attachment 2. Criteria on the Quality of Surface Water According to the Purpose with in DKI Jakarta (Decree of Governor Head of DKI Jakarta, No. 848)

3. APPENDIX OF DECREE OF GOVERNOR HEAD OF DKI JAKARTA (Dated June 30, 1977, No. 484 Year 1977)

CRITERIA ON THE QUALITY OF SURFACE WATER ACCORDING TO THE PURPOSES WITHIN DKI JAKARTA
(The figures inserted constitute the maximum values)

3.1. Criteria on the water quality for Angke river and Pasanggrahan river

Designated Purposes : Agriculture, Fishery

Physics

Electricity conduction capacity	900 micromhos/cm
Temperature	Natural water temperature
Colour	20 scala Pt-Co

Chemical

Quicksilver	0.005	mg/l
Ammonia (as Nitrogen)	2	mg/l
Arsen	0.05	mg/l
Barium	1.0	mg/l
Ferro	1.0	mg/l
Boron	0.5	mg/l
Fluoride	2.0	mg/l
Phosphate	2.0	mg/l/24 hours
Cadmium	0.01	mg/l
Carbon dioxyde	20	mg/l
Chloride	12	mg/l
Chrom (Val. VI)	1	mg/l
Nitrite (as Nitrogen)	1	mg/l
Dissolved oxygen	≥ 3	mg/l
Silver	0.1	mg/l
pH	6-8.5	

Selenium	0.05	mg/l
Zinc	1	mg/l
Sulphate	12	mg/l
Copper	0.02	mg/l
Lead	0.10	mg/l
Substance in Suspension	200	mg/l

Specific characteristics

Natrium absorbing Capacity	10-18	meq/l
Dissolved salt content	630	mg/l
BOD (20° C, 5 days)	20	mg/l
COD	30	mg/l ($KMnO_4$)
Natrium Percentage	60	%

Organic Substance

Chloroform Carbon Extract	0.2 mg/l
Oil and Fat	may not exist
Pesticide	conformed with Regulation of Pesticide Commission
Phenols	0.02 mg/l
Sianide	0.012 mg/l

3.2. Criteria on the water quality for Sekretaris river and Grogol river

Designated purpose: Drainage

Physics

Temperature	Natural water temperature

Chemical

Quicksilver	0.1	mg/l
Ammonia	0.1	mg/l (as NH_3)

Arsen	1 mg/l
Barium	1 mg/l
Ferro	1 mg/l
Fluoride	2 mg/l
Cadmium	1 mg/l
Chlorida	0.05 mg/l (as Cl_2)
Chrom (Val.VI)	0.1 mg/l
Nitrite (as Nitrogen)	1 mg/l (as NO_2)
Dissolved Oxygen	2 mg/l
Silver	0.1 mg/l
pH	6-8.5
Zinc	1 mg/l
Copper	1 mg/l
Lead	1 mg/l
Substance in Suspension	200 mg/l

Specific characteristics

BOD (20^{O} C, 5 days)	30 mg/l
COD	50 mg/l ($KMnO_4$)

Organic substance

Chloroform Carbon Extracts	0.1 mg/l
Hydrocarbon	8 mg/l
Oil and Fat	may not exist
Pesticide	K. Pesticide
Phenols	0.1 mg/l
Sianide	0.1 mg/l

3.3. <u>Criteria on the water quality for Cakung river and Buaran river</u>

Designated proposes : Fishery, Agriculture, Industry Wastes.

<u>Physics</u>

Temperature	Natural water temperature
Electricity conducting-capacity	900 micromhos/cm

<u>Chemical</u>

Quicksilver	0.005	mg/l
Ammonia (as Nitrogen)	2	mg/l
Arsen	0.05	mg/l
Barium	1.0	mg/l
Ferro	1.0	mg/l
Boron	0.5	mg/l
Fluoride	2	mg/l
Phosphate	2	mg/l/24 hours
Cadmium	0.01	mg/l
Carbon dioxide	20	mg/l
Chloride	12	mg/l
Chrom (Val.VI)	0.05	mg/l
Nitrite (as Nitrogen)	1	mg/l
Dissolved Oxygen	≥ 3	mg/l
Silver	0.1	mg/l
pH	6-8.5	
Selenium	0.05	mg/l
Zinc	1.0	mg/l
Sulphate	12	mg/l
Copper	0.02	mg/l
Lead	0.10	mg/l
Substance on Suspension	200	mg/l

Specific characteristics

Natrium absorbing capacity	18 mg/l
Dissolved salt content	630 mg/l
BOD (20^{o} C, 5 days)	30 mg/l
COD	50 mg/l ($KMnO_4$)
Percentage of Natrium	60 %

Organic substance

Chloroform carbon	0.2 mg/l (Fishery Service)
Oil and Fat	
Pesticide	confirmed with Pesticide commission
Phenols	0.02 mg/l
Sianide	0.012 mg/l

3.4. Criteria on the water quality Cipinang river, Sunter river and Kalibaru river

Designated purpose : Drainage

Physics

Temperature	Natural water temperature

Chemical

Quicksilver	0.1	mg/l
Ammonia (as Nitrogen)	0.1	mg/l (as NH_3)
Arsen	1	mg/l
Barium	1	mg/l
Ferro	1	mg/l
Fluoride	2	mg/l
Cadmium	1	mg/l

Chloride	0.05	mg/l	(as Cl_2)
Chrom (Val.VI)	0.1	mg/l	
Nitrite (as Nitrogen)	1	mg/l	(as NO_2)
Dissolved Oxygen	≥ 2	mg/l	
Silver	0.1	mg/l	
pH	6-8.5		
Zinc	1	mg/l	
Copper	1	mg/l	
Lead	1	mg/l	
Substance in Suspension	200	mg/l	

Specific characteristics

BOD (20^{o} C, 5 days)	30	mg/l	
COD	50	mg/l	($KMnO_4$)

Organic substance

Chloroform Carbon Extract	0.1	mg/l
Hydrocarbon	8	mg/l
Oil and Fat	may not exist	
Pesticide	Pesticide Commission	
Phenols	0.1	mg/l
Sianide	0.1	mg/l

3.5. Criteria on the water quality for Cideng river, Krukut river and Ciliwung river

Designated prupose : Drainage

Chemical

Quicksilver	0.1	mg/l
Ammonia (as Nitrogen)	1	mg/l

Arsen	1	mg/l	
Barium	1	mg/l	
Ferro	1	mg/l	
Fluoride	2	mg/l	
Cadmium	1	mg/l	
Chloride	0.05	mg/l	(as Cl_2)
Chrom (Val.VI)	0.1	mg/l	
Nitrite (as Nitrogen)	1	mg/l	(as NO_2)
Dissolved Oxygen	2	mg/l	
Silver	0.1	mg/l	
pH	6-8.5		
Copper	1	mg/l	
Lead	1	mg/l	
Substance in suspension	200	mg/l	

Specific characteristics

BOD (20^{o} C, 5 days)	30	mg/l	
COD	50	mg/l	$KMnO_4$

Organic substance

Chloroform Carbon Extract	0.1	mg/l
Hydrocarbon	8	mg/l
Oil and Fat		
Pesticide	% is determined by Pesticide Commission	
Phenols	0.1	mg/l
Sianide	0.1	mg/l

1.6. Criteria on the water quality Banjir Kanal channel

Designated purpose : Drinking Water Raw Material.

Physics

Electricity conduction-capacity	1000	micromhos/cm
Muddiness	400	mg/l (SiO_2)

Chemical

Ammonia (as Nitrogen)	0.5	mg/l
Arsen	0.05	mg/l
Barium	1.00	mg/l
Ferro	0.5	mg/l
Boron	1.00	mg/l
Fluoride	1.5	mg/l
Cadmium	0.01	mg/l
Calsium	200	mg/l
Chloride	150	mg/l
Chrom (Val.VI)	0.05	mg/l
Magnesium	150	mg/l
Natrium	0.5	mg/l
Nitrate (as Nitrogen)	45	mg/l
Nitrite (as Nitrogen)	45	mg/l
Dissolved Oxygen	4-5	mg/l
Silver	0.05	mg/l
pH	6.5-8.2	
Selenium	0.01	mg/l
Zinc	15	mg/l
Sulphate	400	mg/l
Copper	1.5	mg/l
Lead	0.05	mg/l

Specific characteristics

BOD (20^{o} C, 5 days)	5	mg/l
COD	10	mg/l

Organic substance

Chloroform Carbon Extract	1 mg/l
Oil and Fat	may not exist
Pesticide	conformed with Regulation of Pesticide Commission.
Phenols	0.002 mg/l
Sianide	0.20 mg/l

Radio activity

Gross Beta	1000 pc/l
Radium	3 pc/l