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**Feasibility Study for the  
Water Supply and Sewerage Scheme,  
Accra-Tema Metropolitan Area, Ghana**

**Record of Conference**

**held in Tel Aviv**

**August 8 - 11, 1966**

TEL AVIV  
SEPTEMBER 1966

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This is a brief record of the conference held in Tel Aviv in August 1966 to consider the drafts of the Feasibility Study and the Financial Report prepared for the Accra-Tema Water Supply and Sewerage Scheme.

The conference followed a meeting held at the beginning of the same month in Geneva between officers of the WHO, members of the Advisory Panel, and representatives of the World Bank.

Upon arrival in Tel Aviv, the group was joined by a representative of the Government of Ghana and by a member of AFRO Brazzaville, as well as by representatives of the Consultants—TAHAL (Water Planning) Ltd., and Engineering Science Inc., on the one hand, and the Public Administration Service (PAS) of Chicago, on the other hand.

The conference took up 5 sessions, all held at the offices of T A H A L, who acted as hosts to the participants.

In advance of the conference, the consulting firms sent copies of their respective contributions to the Feasibility Study, in draft form, to the participants. Supplementary material, including drawings and diagrams, was presented to the conference during the discussions.

After conclusion of the conference, its official members took leave of the Consultants and proceeded to Accra for consultations with the Government of Ghana.

## C O N T E N T S

	<u>Page</u>
LIST OF PARTICIPANTS	2
SUMMARY AND CONCLUSIONS	3
<u>First Session (August 8th, 1966 - morning)</u>	7
A. <u>GENERAL COMMENTS AND STATEMENTS</u>	7
1. Report on meeting with Mr. Armstrong	7
2. Proposed meeting in Brazzaville	9
3. Nature of Feasibility Report	9
B. <u>FINANCIAL ASPECTS</u>	10
1. The P A S Report	10
2. Ability to pay	11
3. Water rates structure	12
4. Scope of financial study	13
<u>Second Session (August 8th, 1966 - afternoon)</u>	15
5. Escalation of costs	15
6. Water losses and defaulting payments	16
<u>Third Session (August 9th, 1966 - morning)</u>	17
7. Design criteria	17
<u>Fourth Session (August 9th, 1966 - afternoon)</u>	22
C. <u>WATER SUPPLY</u>	22
1. Present situation	22
2. Population trends	23
3. Water consumption	23
4. Fire flows	24
5. Filter beds	24
6. Automatic operation	24
7. Use of chemicals	25
8. Standby pumps	25
9. Water treatment	25
10. Interim measures to postpone investments	26
11. The Densu works	27

C O N T E N T S - C O N T D .

	<u>Page</u>
<u>Fifth Session (August 11th, 1966 - morning)</u>	27
D. <u>SEWERAGE</u>	27
1. Review of ESI Report	27
2. Implementation priorities	28
3. Sea outfalls	29
4. The sewer system	30
5. Public health aspects	31
6. Implementation aspects	32
E. <u>CONTENTS OF FEASIBILITY REPORT AND CONCLUSIONS</u>	33
 <u>APPENDIX: Feasibility Report Tables of Contents</u>	 34

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Mr. L. J. Lovelace                    Regional Adviser in Environmental Health; Personal Representative of the Director General, A F R O , Brazzaville

World Bank Representative:

Mr. Rajagopalan                      World Bank Representative

Government of Ghana Representative:

Mr. G. B. Hogan                      Senior Engineer (Civil) Project Co-Manager, WHO/U. N. Special Fund, Accra, Ghana

WHO Advisers:

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In Attendance:

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## SUMMARY AND CONCLUSIONS

A conference to consider the draft of a feasibility study made by the engineering and financial consultants for the Accra-Tema Metropolitan Area Water Supply and Sewerage Scheme was held in Tel Aviv in August 1966. The conference was attended by senior members of WHO and of the Government of Ghana, by a representative of the World Bank, by members of the WHO Advisory Panel, and by representatives of the engineering consultants, TAHAL and ECI, and of the financial consultants, PAS.

During five sessions held between 8th and 11th August, the conference considered all parts of the draft feasibility report which relate to the Second Stage of the Water Supply and to the First Phase of the Sewerage Scheme. The report was confirmed subject to the provisions and modifications set out below.

While the engineering features of the scheme are to remain largely as proposed in the Master Plan of 1965, an alternative implementation programme should, in the recommendation of the conference, be spelled out, which would be spread over a longer period than originally envisaged, owing to the now anticipated slower pace in the development of the Metropolitan Area. This will also necessitate an additional financial analysis to be made on the basis of the minimum water demand curve given in the draft of the feasibility report. To comply with IBRD requirements, this analysis, like the one based on the original "design" curve for demand growth, will adopt a rate structure varying in accordance with annual expenditure and water consumption, with a view to making the Water Corporation self-supporting from the outset.

The Feasibility Study will encompass both an overall analysis of the financial situation, and a separate analysis of the Second Stage of the Water Supply Scheme by itself. An annual escalation of costs at the rate of 4% will be assumed.

To ensure the success of the scheme, the conference stressed that a highly efficient management must be set up.

In the water supply part of the scheme, the per capita consumption of water in the Second Stage will be taken as 10 gpcd for standpipes and 18 gpcd for house connections. No special allowance will be made for fire flows, since the normal flows will be sufficient for fire fighting.

It was further agreed to consider raising filtration rates in the filter beds included in the scheme, in keeping with recent developments. The operation of the filters will be semi-automatic.

A leakage survey, together with an investigation as to the advisability of lining existing mains with cement, will be included in the new UNDP programme recently approved by the Special Fund.

In respect of the sewerage part of the scheme, the conference found it desirable to give high priority to improving the sanitary conditions in the two towns and at the lagoons, while leaving the construction of the sea outfalls to the latter part of Phase One of the sewerage programme. The minimum economic length of constructing the first section of a sea outfall is to be studied.

Emphasis will be given in the report to the fact that the present collection and tipping services involve high costs, which will offset part of the cost of the proposed new sewerage scheme.

A statement is to be included in the report on the overall aspect of priority of implementation.

The principal conclusions reached at the conference are listed below.



1. In the present P A S Financial Report, the following corrections will be introduced:
  - (a) Physical water losses will be taken at 25% for the period 1967 to 1971; 20% for the period 1972 to 1976, and 15% for the period 1976 to 1983.
  - (b) Water sales figures will be adjusted.
  - (c) Estimated default in revenue collection from industrial consumers will be reconsidered, on the assumption that an effective operating authority will be established and will gradually decrease the percentage of defaults.
  
2. An alternative financial analysis, in addition to the one presented in the Financial Report, will be carried out by P A S. This alternative will be drawn up on the following assumptions:
  - (a) Water demand will be in accordance with the minimum curve given in the draft feasibility report.
  - (b) T A H A L will supply to P A S an alternative investment curve for completion of the First Stage and the Second Stage water supply scheme, which will be timed so as to fit this minimum demand curve.
  - (c) E C I will supply to P A S an alternative investment curve for the First Phase sewerage scheme, which will be spread out over the entire construction period of the Second Stage water scheme in such a manner as to obtain uniform aggregate annual investments both for water and sewerage.
  - (d) It will be assumed that at the point of time, when the Government of Ghana approaches a financial institution for obtaining a loan for the construction of the First Phase of the Second Stage water scheme, default in revenue collection will have been reduced to 15% and physical water losses also to 15%.
  - (e) Water and sewerage rates will be calculated according to World Bank rules allowing for an annual escalation of 4% compound.
  - (f) Phases One and Two of the Third Stage water supply scheme will not be included in the alternative financial plan. The following footnote will be made by P A S in the respective tables.

"Phases One and Two of the Third Stage water supply scheme will, in accordance with the minimum demand curve, become operative in 1984 and 1993, respectively. Financial planning for these phases will at present be of little significance. It has therefore not been included in the table."

Mr. Armstrong asked whether, in the circumstances, the preparation of designs was not premature. To this Mr. Wiener pointed out that, in the past, the opposite had occurred: even before a contract was signed in 1964 with the WHO, the Consultants had been asked by the Government to produce a layout; as a consequence the Consultants had to work under great pressure of time. It seems far better to have, under the most conservative assumptions, a design on the shelf, for a year or so, than to have to work again under duress of time.

b. Water Authority

Mr. Armstrong pointed out to Mr. Wiener that the World Bank before considering a loan application, wanted to be convinced that the administration of the water supply system would be adequately manned and organized. He was then informed by Mr. Wiener that the Government of Ghana had already begun to organize the Water Authority. Consolidating the organization might take some time, but the Authority will most probably be fully operative by the time the new system begins to function.

c. Water rates structure

Mr. Armstrong then raised the question of whether the income from water rates was adequate for covering the costs. In this connection, the problem of escalation was discussed, and the conclusion was reached that it was quite impossible to predict future inflationary movements in Ghana. Introducing any escalation in the calculations would mean bringing in an entirely arbitrary factor, and unnecessarily obscuring the true values, as expressed in factors of the economy. Mr. Wiener pointed out that any economic evaluation of alternative interventions ought to be worked out on the basis of constant prices, that is to say, actual economic values. Unlike the American economy, where escalation can be estimated, Ghana has an entirely unpredictable rate of inflation.

Mr. Armstrong fully agreed that the best method of economic evaluation would be in this case a method based on constant prices.

d. Filtration rate and automation

One of the specific comments made by Mr. Armstrong was that the filtration rate assumed for the water treatment plants appeared to be much too low. He was then assured that the relevant figures would be reconsidered in the light of present-day practice and of tests to be conducted with Volta River water in existing installations.

Mr. Armstrong's other specific comment was that the recommendation on automation in the filters given in the report was too far-reaching. Most automatic arrangements in such installations did not, in his experience, function properly. Mr. Wiener agreed to reconsider the wording of the recommendation, the actual intention being to have semi-automatic controls.

2. Proposed meeting in Brazzaville

Mr. Lovelace, who speaks next, informs the Panel that Dr. Canaan, the Director General, AFRO, Brazzaville, wishes the Panel to come to Brazzaville for a discussion on the continuation of the work on the Project. Mr. Lovelace inquires whether a TAHAL Representative could also come, and Mr. Wiener replies that, if an invitation (unofficial) is received by TAHAL, the Company would be represented. Mr. Hagan supports the proposal.

3. Nature of the Feasibility Report

Prof. Krul, by way of introduction to the forthcoming discussions, states that the Panel feels that the Government of Ghana has come into possession of a first class report—the 1965 Engineering Report by TAHAL and Engineering Science Inc.

The next step to be taken is the realization of the Scheme, and the Feasibility Study, together with the Financial Report, now presented in draft, must give the Panel an understanding of what the Consultants propose to be done. After conclusion of the present conference, the Panel hopes to be able to report to WHO and to the Government of Ghana on the work done by the Consultants, and on the ways to be followed in realizing the Scheme.

Among its other recommendations, the Feasibility Report must indicate how a sound financial basis could be provided for the Project, what rates should be charged for the water supply and sewerage services, and how to ensure good management of the proposed Corporation, which must become a self-supporting agency.

B. FINANCIAL ASPECTS

Mr. Dieterich, in opening the discussion on the financial aspects of the Project, proposed that a brief review of the PAS draft report should first be heard.

1. The PAS Report

Mr. Jacobi then outlines the contents of the PAS draft report, which has been drawn up in accordance with the terms of the supplementary agreement between the PAS and WHO. The Report follows the relevant World Bank questionnaire, and, in answering it, the PAS used the information gathered in Accra by its own personnel, and also data supplied by the engineering consultants.

The proposals made in the Report stem from an endeavour to make the Corporation self-supporting, and the simple rate structure indicated is one that can accomplish this purpose. The figures given include for annual escalation of costs. Generally, the estimates show the expenditure to be high and the income low. If, however, escalation is excluded, the position will be more favourable.

Water losses in the system have been taken into account, and on the effectiveness of water rates collection a realistic view has been taken. However, with proper management, collection may progressively increase to 85%.

2. Ability to pay

The ability of the consumer to pay for the water supplied to him is then discussed. The fact is noted that the low-income consumer who draws his water from a standpipe does not pay for the supply directly, the cost being covered from municipal taxation. Only owners of house connections pay directly for their water, the present monthly charge in Accra per unmetered connection being \$2.80. This charge is proposed to be increased in 1967 to \$3.50, in view of the intention to put the Corporation on a self-supporting basis. The present Government subsidy to the Water Supply is 50%.

The envisaged procedure is that the Water Supply Corporation will determine the rate and, when approved by the Government, the Municipality will collect. Thus, part of the cost of water will be covered by taxation, and part by rates based on the current cost of water.

An analysis made by P A S shows that the cost of water in Accra will amount, on the average, to 5.6% of the family income. In Tema the cost is as high as 7% for a family income of \$50 per month, but only 1.8% where the family income is \$200. In 1970, P A S estimates the average monthly domestic water bill to be about \$4.

Mr. Hagan, asked by the Chairman for his views, states that the present water rates are too low and must be increased. The townspeople are used to paying a considerable part of their income for water. They often resort to the services of water vendors who charge 3 d. per 4-gallon container. Since

the daily consumption per head is about 8 gallons, the cost of water per person is generally more than £2.0.0. per month and is paid quite willingly. Since water will now be provided close to the houses and will be of good quality, the average family will be quite willing to pay the increased rates. The Government, Mr. Hagan feels, will not be against increasing the water rates, for they consider that the water must be provided.

### 3. Water rates structure

The next item taken up is the water rates structure. A lengthy discussion evolves in which two opposing views are expressed.

One view is presented by Mr. Wiener who suggests modifying the basic calculations given in the P A S Report, where the water rates are varied from year to year in accordance with annual expenditure and water consumption. In any economic project or business undertaking, there is a development period, during which the capacity resulting from the investments made is not fully used. It is an accepted view, Mr. Wiener points out, that the rates charged by a public utility are not computed for every year by itself but are made uniform throughout. He recommends that a uniform water rate be proposed over the whole lifetime of the present Scheme. For the initial period, when water consumption is low and collections lagging, while heavy fixed annual costs must be paid, the bulk of these costs should be capitalized and added to the investments. He does not therefore recommend a high initial water rate, but a medium rate which would, over the lifetime of the Scheme, cover all costs. The difficulty that will be caused in the initial period by insufficient cash flow should be met, Mr. Wiener considers, by an extended grace period granted by the Government on the early payments due on its own part of the loan. This is, indeed, the procedure adopted by the World Bank in irrigation projects, usually taken to serve 40 to 60 years. The expenditure for such period, and the income for the same period are calculated, and the two (in present worths) must balance, while the water rate is kept uniform. If this is done in the present case, the rate may come down to as low as 40 or 45 ¢ per 1,000 gallons.

The opposing view is expressed by Messrs. Jacobi and Hettler, who defend the method adopted in the PAS Report. The rate structure embodied in that report is worked out on the assumption that the Corporation must be self-supporting from the outset. To spread initial losses over the whole period would mean that the Corporation would run into great deficits in the early period. Cash deficits will have to be made up by the Government either by borrowing, or by reducing expenditure on its other projects. The initial rate of 58 ¢ proposed in the PAS Report is computed to balance expenditure with income from the start.

Mr. Hagan, asked for his views, states that the Government will want the Corporation to be self-supporting as soon as possible.

Mr. Rajagopalan states that the procedure adopted by PAS complies with IBRD requirements.

It is accordingly concluded that a varying rate structure, as proposed by PAS, be adopted.

#### 4. Scope of financial study

The Chairman then asks for the participants' views as to how the financial investigation should be made. Should it cover both the existing and the future systems, or the Second Stage alone?

Mr. Wiener notes here that, under the terms of reference, a feasibility study is to be made of the Second Stage alone, and is to show the investments required for this stage and to investigate the ability of the undertaking to pay the resulting costs. He has, however, no objection, to the study of the Second Stage by itself being presented alongside with the overall financial situation.



Mr. Jacobi states that the P A S Report presents the overall financial situation at the conclusion of the Second Stage, and submits that it is extremely difficult to separate the Second Stage.

Mr. Rajagopalan, asked whether an analysis of the overall financial situation would meet the World Bank requirements, replies that some further details would be needed. The World Bank wants a cost-benefit analysis, and both the overall analysis and the analysis of the Second Stage by itself are quite necessary.

After further discussions and consultations, it is finally agreed that the P A S Report be supplemented by a separate financial analysis for the Second Stage.

S E C O N D   S E S S I O N

Monday, August 8th, 1966 - afternoon

5. Escalation of costs

The discussion now turns to the question of cost escalation, for which a 4% annual increase (compound) has been allowed in the PAS Report. The view expressed by Mr. Wiener is that true economic, rather than money values should be considered in evaluating the feasibility of the Scheme. The introduction of 4% escalation in the present context is meaningless; in a study expressed in economic terms there should be no such arbitrary escalation. Since income will rise at a similar rate as expenditure, the introduction of escalation will only change the yardstick. Mr. Ludwig remarks in this connection that, by excluding escalation it can be shown that the true cost of water will, in the course of time, go down.

Mr. Hettler, on the other hand, points out that PAS has made a financial, not an economic study. The financial planning by PAS is purposely conservative.

Asked for the World Bank stand on this question, Mr. Rajagopalan informs the meeting that escalation is accounted for in some cases. The water rates charged will generally follow the rise in costs with some delay, and the time lag may be as much as five years in some countries.

Prof. Krul maintains that if the Second Stage is considered to be financed by a World Bank loan at, say, 7% interest, then, by assuming a 4% annual escalation for the duration of that stage, a clearer idea as to its feasibility can be obtained. The same considerations will apply to the sewerage part of the Scheme.

This view is, after further discussion, accepted by the meeting and it is agreed to include escalation in the calculations.

6. Water losses and defaulting payments

In introducing the question of losses for which allowance must be made in the computations, Mr. Dieterich points out the present low efficiency in the collection of water rates. An assumption that 50% of the rates is now being collected would be very liberal. New collection procedures have been introduced in Accra and Tema, but the available staff is as yet unable to implement them. It will take two or three years to attain efficiency. Public acceptance will take longer. If collection goes up to 80% in two years, then the chosen rate structure can become effective in 1969.

In the ensuing discussion, the distinction between losses due to leakage in the system and losses due to inefficient collection of dues is pointed out. In the PAS Report it appears that some losses are duplicated by being accounted for twice. It is then agreed that the necessary corrections in the Report be made.

The meeting then adjourns to allow the participants to hold informal consultations among themselves.

T H I R D   S E S S I O N

Tuesday, August 9th, 1966 - morning

7. Design criteria

In opening the session Mr. Dieterich reviews the procedure involved in dealing with the present Feasibility Study. The report is being prepared by the Consultants—the TAHAL-ESI partnership and the PAS—under two contracts entered by the WHO. The report will be read by WHO, and they will prepare their own report to the Government of Ghana. That report will present the views of WHO on the Consultants' conclusions, and might include additions to and modifications and even reversals of the Consultants' recommendations.

As far as the financing of the Scheme is concerned, it is hoped that the World Bank may become interested and may eventually decide to grant a loan. No one has asked for the loan yet, and it is the Government of Ghana that will decide whether and when to apply for it. It is premature to make a guess; however, the report is being drafted in keeping with World Bank requirements. Its recommendations must be technically sound and realistic.

During yesterday's discussions, a proposal was made by TAHAL to depart from the design figures adopted in the Master Plan, and to base the computations on the minimum demand curve presented in the draft of the Feasibility Report. This is a matter that gives rise, in Mr. Dieterich's opinion, to considerable misgivings, and he wished to know the reason for this departure. Does it stem from sound engineering considerations, or merely from financial expediency? Do recent developments warrant a modification of the design criteria? Why just that minimum curve and not another?

Prof. Krul joins the discussion by saying that it is essential to see what effect the rates will have on the average man in Ghana. The recent developments in Ghana have given rise to increased uncertainty as to the likely rate of demand growth. For this reason, there should be an additional proposal worked out, based on minimum figures, and the combined charge for water and sewerage should be determined.

Mr. Wiener, in explaining his proposal, states that he understands Mr. Dieterich's misgivings. By referring to the diagram showing curves for minimum, medium and maximum rates of development, Mr. Wiener says that the actual development curve might be assumed to fall somewhere within the probability space between the maximum and the minimum curves.

At the time the Master Plan was drawn up, there were good reasons to believe that the medium, the "design" curve was the most probable trend. Now, in the changed circumstances, it appears that the actual development curve may be somewhere in the lower half of the said probability space. If the general economic development is slow, and since there is a certain per capita income elasticity of demand, consumption will be lower and the burden of water rates on the income less. The present proposal is to investigate the minimum curve. This curve, and the original "design" curve will indicate the limits of the likely development during the next seven years.

Investigating a construction schedule based on the minimum curve does not constitute a departure from the stand taken in the Master Plan. For a slower moving economy there should be a lower project burden, and vice versa. The actual course of the demand curve will be a result of the actual growth of the economy. For a reliable forecast there is little to go by. Should a World Bank economic mission come out with a new report on Ghana, this would be a very valuable document for estimating short-term demand trends. At present, there is no information on the intended industrial development, on

housing schemes, etc. All that can be said is that the actual demand development during the coming seven years can be assumed to fall somewhere between the two curves.

Mr. Rajagopalan offers the observation that if anybody is in a position to assess the trend of future development, this should be the Consultants. They must tell the Client what in their view is the most feasible project under present circumstances.

Asked whether sufficient data are available to figure out a new curve which would now represent the lower limit of probability, and be closer to reality than the minimum curve plotted in 1964, Mr. Wenderow details the information at hand.

It has been possible, he states, to investigate to some extent the position of industries in the very near future; industrial water consumption has been taken as somewhat less than the minimum figures given in the Master Plan. For domestic consumption, the minimum figures in the Master Plan have been taken unchanged. As a result, the minimum figures in the Feasibility Report are essentially the same as in the Master Plan, except for a reduction in the industrial consumption, it being considered that the original seven-year industrial plan will not be carried out at the anticipated rate.

The Government of Ghana has now embarked on a consolidation survey, which may possibly result in a slowing down of the original industrial programme.

The domestic consumption is likely to be in accord with the "design" curve, to the extent that it will not be significantly influenced by the ability of consumers to pay. Should the economic situation cause a significant drop in the real family income, municipal water consumption may drop.

To a question by Prof. Krul as to whether the average Ghanaian will be able to set aside some 8% of his income for water and sewerage, Mr. Hagan considers that he will be prepared to pay. The Government, Mr. Hagan adds, is now about to raise the wages of its employees, and, in their case, the percentage of income spent on water will consequently go down.

In the continuing discussion, Mr. Wiener refers to a working paper distributed by him among the participants, in which an alternative financial analysis is proposed, based on minimum assumptions, in addition to the one based on the "design values", as given in the PAS Report.

This and other proposals are discussed, and Mr. Dieterich summarizes the conclusion reached. As a result of changed circumstances, Mr. Dieterich says, there is much uncertainty as to the design figures, and there is a feeling that the actual growth of water consumption in the future may be lower than the design curve. It is therefore considered necessary to present to the Government of Ghana an alternative, more modest programme, which must be accompanied by a corresponding financial programme. The Scheme itself remains unaltered, and the only change is in its timing and in the resulting financial and fiscal consequences. It will be for the Government of Ghana to decide which programme to adopt in the light of future demand trends. This must be stressed in the WHO introduction to the Feasibility Report. The reason for the high water rates must be clearly shown as the outcome of Government instruction to make the Corporation self-supporting from the outset, and to do away with subsidies.

In this connection, Prof. Krul proposes the following statement for inclusion in the Feasibility Report:

- "(i) A self-supporting Corporation should be established.
- (ii) To meet this end, the P A S calculations have shown that water rates should be increased by .....%
- (iii) It is necessary to implement the Second Stage of the Water Supply together with the First Stage of Sewerage. This will necessitate increasing the total combined rates for water and sewerage to .....%, and will represent a total burden of .....% of the population's income."

This statement, Prof. Krul says, will show clearly what it means in increased rates to make the Corporation self-supporting.

Prof. Krul further suggests that the table of contents for both parts of the amended Feasibility Report, engineering and financial, be drawn up before the conference is concluded. This suggestion is accepted. Prof. Krul adds that in the Feasibility Report a statement is needed on the management of the Corporation which is at present in a sad state, though last year some improvements have been made. The report should make it quite clear that if a very good management is not set up, there can be no hope to make the Scheme a success.



F O U R T H   S E S S I O N

Tuesday, August 9th, 1966 - afternoon

C. WATER SUPPLY

In opening the discussion on the engineering aspects of the Scheme, the Chairman proposes to take up water supply first and sewerage next.

1. Present situation

The present state of the water supply is reviewed by Mr. Wenderow, who states that the First Stage, under execution by Messrs. STEPRI, is about to be completed soon, this stage having suffered a delay of one year. The 42-inch pipes from Kpong to Tema and from Tema to Accra have been completed and connected to existing headworks. This has made it possible to increase supplies considerably.

Testing of the new installations will take place in the coming September and October, and the final commissioning will be carried out early next year.

By April 1967, the installations built by Messrs. STEPRI will be fully operative. Additional items of work, including extensions to the distribution system, will be put in hand in October 1966, and will also be completed by April 1967. Thus extended, the system will suffice for meeting the needs in 1967 and 1968. More pipes will then have to be laid to take up the full Kpong capacity.

Mr. Wenderow concludes his review by stating that the First Stage of the Water Supply Scheme, as carried out by Messrs. STEPRI, forms an integral part of the Master Plan and its design is based on the same criteria.

2. Population trends

The discussion turns to the design criteria given in the Master Plan, and the question is first considered whether the envisaged population trends need be revised in the light of developments during the past two years.

Mr. Wiener points out in this connection that little can be added to what was said a year ago, but any possible changes in population trends will not be very significant for the Feasibility Report. He agrees, however, that some modifications will be needed in the wording of the relevant section, and that reference should be made to the minimum assumptions now adopted for study as an additional alternative.

3. Water consumption

The question is raised whether the figures for per capita consumption are not exaggerated. Mr. Wiener and Mr. Wenderow explain that these figures are based on local experience, and have been endorsed by earlier meetings with the Board of Consultants and by Prof. Wolman from his knowledge of conditions in Asian and South American countries.

Any variations that may be caused by slower housing development will all fall within the area between the design and the minimum curves. With the present consumption being 6 gpcd, the minimum curve shows 10 gpcd in 1970 and 15 gpcd in 1980. The closer spacing of standpipes, which is a primary need, will naturally lead to increased consumption. Furthermore, in the sub-standard areas, public sanitary facilities are to be provided. Their water consumption has been included in the per capita figures.

Since much of the water drawn from standpipes is being used on the spot—for laundrying, ablution, etc.—the doubt is expressed whether, in the absence of sewerage, a generous supply of water may not cause waste water accumulations on the ground and lead to insanitary conditions around the standpipes.

For this and other reasons, it is finally agreed to allow in the Second Stage up to 10 gpcd for standpipes and 18 gpcd per house connections.

4. Fire flows

In the discussion it is pointed out that no special provisions are necessary for fire flows, since the supply flows in the system would be sufficient for fire fighting. It is accordingly agreed to reword the relevant paragraph in the Feasibility Report by excluding the reference to special provisions for fire flows.

5. Filter beds

In respect of the filter beds proposed in the Feasibility Report, Mr. Rajapolagan expresses the view that the size of a filter of 5 mg capacity may prove to be impracticable. Mr. Corlett, however, points out that with increased filter rates no excessive filter sizes are needed. In the U.S.A., filters now operate at the rate of 5 or 6 gallons per sq. ft. per minute. He proposes that the Consultants consider adapting the filters to higher flows, noting that turbidity removal in rapid sand filters at 5 to 6 gallons per sq. ft. is better than at 2.5 g. p. s. f.

The proposal to investigate higher filter rates is accepted. It is also agreed to refer in the design criteria for the filters to "peak day", not "peak season".

6. Automatic operation

The lack of confidence in the automatic operation of filters is then brought up, in the light of unsatisfactory experience in developing countries. It is agreed to specify semi-automatic operation, with the possibility for future conversion.

7. Use of chemicals

The need to reconsider the heavy use of chemicals specified in the draft report, in view of the high costs involved, is urged by Mr. Rajagopalan. Mr. Wenderow observes that the figures used are based on the experience at Weija and Kpong. However, when the detailed design is embarked upon, a further study will be made of the question, with a view to keeping the expense at a minimum. It is anticipated that storage of the water in lakes and reservoirs may help to reduce the amounts of chemicals needed.

To a question by Mr. Lovelace, Mr. Wenderow replies that provision is made for eventual prechlorination, which will be applied when needed. At present it is not clear whether it will actually be required.

8. Standby pumps

Mr. Rajagopalan inquires why the three pumps provided for the supply of 30 mgd must all be designed for the peak load of 15 mgd each.

Mr. Wenderow explains that, in the event of a breakdown, any one of the three pumps may remain out of commission for a lengthy period, when the two other pumps may be called up to supply the peak demand of 30 mgd.

9. Water treatment

Mr. Dieterich inquires for the reason for providing aeration. Mr. Wiener relates that iron, manganese and carbon dioxide have been found to increase as a consequence of storage of river water in Nigeria. These and other undesirable substances will surely appear after some time in the Weija system, owing to the decomposition of organic matter in the impounding reservoir. The likelihood of a similar situation arising in the Great Volta Reservoir cannot be assessed.

Asked by Mr. Lovelace about the acidity of the water, Mr. Wenderow replies that the pH factor is generally about 7, but has dropped during some periods to below 7.

Prof. Krul suggests that the cascade method of aeration be adopted, rather than sprinklers, which involve a greater loss of head. Mr. Wiener adds that a functional specification could be issued to tenderers to offer their own competitive proposals.

10. Interim measures to postpone investments

Mr. Dieterich poses the question, to what extent can it be hoped to postpone construction, if leakage is reduced. Some parts of the distribution system are new, but there is leakage in its other parts, and no information exists as to its extent.

A leakage survey is needed and an estimate should be made of the amount of water that could be saved by a rehabilitation programme lasting, say, one year.

Mr. Corlett adds that, before a leakage survey is made, one must make sure that all valves are in good working order and that any line can be closed down and completely separated from the system. The survey should include the determination of the C coefficient in mains to determine the advisability of lining them with cement.

The conclusion is reached that a leakage survey is to be carried out, and that a relevant statement should be made in the Feasibility Report.

11. The Densu Works

Mr. Dieterich points out that, according to the wording of the report, the figure of 40 mgd from the Densu system appears to be determined rather arbitrarily. The relevant paragraph should be reworded.

F I F T H S E S S I O N

Thursday, August 11th, 1966 - morning

D. SEWERAGE

Mr. Lovelace takes the chair and requests Mr. Ludwig to give a brief review of the sewerage part of the Scheme.

1. Review of ESI Report

Mr. Ludwig refers to the summary in the report by Engineering Science Inc., distributed among the members in advance of the meeting. The summary contains data of the existing sewerage works at Tema and describes the present method of disposal. Available data on the incidence of water-borne and filth-borne diseases are also given. The necessity to provide adequate sewerage also in Accra is stressed, together with the need to remedy the situation at the lagoons.

At Tema, the programme set out in the Feasibility Report will provide for the continuation of orderly development. The west side of Tema is next to experience the impact of housing development. The relevant design criteria are those given in the Master Plan; the Panel is acquainted with these criteria and the general method of design, including provision of pumping stations. Staged development is envisaged, under which the pumping stations will be constructed in stages as flows build up.

The method of sewage treatment has been described in the Master Plan. The final arrangement envisaged is building a number of sea outfalls 5,000 ft long, to be extended later and provided with diffusers and treatment

facilities. Sites have been selected for the pumping stations and treatment plants, and these are being acquired by the Government.

Minor departures from the Master Plan have been made in the system. Some pumping stations had to be moved owing to unfavourable ground conditions, others—owing to non-availability of the chosen site. Essentially, the system remains the same. In Accra, it will comprise 27 miles of main sewers and 60 miles of secondary sewers. It will also comprise 5 large and 3 small pumping stations.

At Tema the programme is limited to 3 existing pumping stations. It provides for diverting the flow to the west and constructing the main sea outfall. Additional field studies have been made for further pumping stations. Some are very deep.

The construction schedule for Accra covers the 5-year period 1968 to 1972, whereas the facilities for Tema are all to be provided by 1968. This schedule has now been reconsidered in the terms of the minimum rate of growth, and the revised schedule may now become stretched out over a period of 10 years.

The outline specifications for the required materials have been included and estimated costs given in tables appearing in the report.

Maintenance costs have been estimated with the help of P A S, and have been included in the P A S submittal.

## 2. Implementation priorities

As the construction schedule may now be spread out over as much as ten years, Mr. Wiener considers it essential to lay down an order of precedence for the different phases of the sewerage programme, in keeping with the relative urgency of the needed sanitary improvements. If progress is to be in keeping with the minimum schedule, he proposes that the cleaning up of the two towns

and of the lagoons be carried out prior to the construction of the outfalls, in the knowledge that beach pollution would unavoidably become aggravated.

Prof. Krul agrees with this view and stresses that Phase One of the sewerage programme should be the reconditioning work on the Korle Lagoon. Next should come the house connections to the sewer system, and last, the construction of the outfalls.

### 3. Sea outfalls

Asked by Mr. Lovelace for further details, Mr. Ludwig replies that, to start with, two outfalls will be needed, but their number would eventually be increased to four. The distances between the four outfalls, from east to west will be 9 miles, 6 miles and 9 miles. The cost of the first two outfalls is estimated at \$3.8 million, out of the total of \$21 million for the First Stage of the sewerage programme. Mr. Wiener, in referring to the number of outfalls, offers the view that, owing to the uncertainties concerning future development, it is preferable to have a larger number of outfalls of smaller size. This will result in committing smaller investments at any one time, the cost of outfall construction being generally high.

A lengthy discussion develops as to the initial length to which an outfall should be built, and Prof. Krul expresses doubts as to the need for a length of as much as 5,000 ft. (1,500 m) to begin with. In the Hague, he states, a 400 m long outfall has been in satisfactory service for the past 100 years, while no treatment except straining has been given to the sewage. In Cannes a 300 m outfall is in use. In this case, comminution has helped to postpone outfall construction. Prof. Krul asks whether an outfall 600 ft long would not suffice for the beginning.



Mr. Ludwig explains that the four ocean studies made, though covering only a short period, were carried out in different seasons of the year and that the data are reasonably representative. The sea near the Ghana coast is very shallow, and the length of 5,000 ft is admittedly not quite enough, and will have to be extended at a later stage. However, since the outfalls are likely to be constructed only at the end of the First Stage of the sewerage scheme, fuller knowledge of the ocean conditions will have become available by then.

In the very costly outfall construction, Mr. Ludwig continues, the minimum size of a contract must be considered. A length of 5,000 ft can absorb the initial expenditure on preliminaries and arrangements for construction. For this reason, a length of only 600 ft would not be practicable.

At the conclusion of the discussion on outfall sewers, it is agreed that in the Feasibility Report the reasons for postponing the construction of the outfalls be given, together with a meaningful statement on the minimum practicable length of the sea outfalls.

#### 4. The sewer system

In referring to the cost of the proposed sewage disposal system, Mr. Corlett mentions that at previous meetings Mr. Townsend emphasized the very high costs already incurred in paying for the present primitive methods of disposal. The provision of sewers will eliminate these methods and will not increase the costs very much. Mr. Ludwig adds that the present annual cost of collection and tipping is £160,000. Though the programme will not eliminate this expenditure all at once, it will become gradually eliminated during the 5 or 10-year period.

It is then agreed to have this point emphasized in the report.

Another point brought up by Mr. Corlett is to the effect that a statement should be included in the report defining the desirable position of sewers in the streets, whether in the centre or at one side. It is agreed to have such a statement included and to say that, generally, it is desirable to have the sewer down the middle of the street, especially in the case of laterals.

Mr. Ludwig adds that in very wide streets two sewers, one on each side, would be preferable. In some cases it may prove desirable to lay a small sewer first, and duplicate it at some future time.

#### 5. Public health aspects

The question is next discussed as to whether public health reasons should be given in the Feasibility Report in support of the sewerage scheme. The relevant IBRD questionnaire is referred to, which calls for quoting statistics on water-borne and filth-borne diseases. It is, however, pointed out that the available statistics are very scanty and unreliable, and will not constitute a convincing argument. In general, it is felt that justifying costly water and sewerage schemes by reasons of public health alone may prove very difficult. Economic reasons appear to be greatly more valid.

After a lengthy discussion, it is finally agreed to include a descriptive paragraph in the Feasibility Report on the public health situation, but present the available statistics in the appendix.

Further discussion of the public health situation can be left to the WHO who may wish to include it in their own report.

6. Implementation aspects

In a general discussion on the implementation of the sewerage scheme that next takes place, Mr. Rajagopalan is requested to summarize his views. His main comment is that the sewerage scheme is necessary as an adjunct to the water supply scheme. A flexible plan has been presented; the schedule of construction has been extended over a longer period than envisaged in the Master Plan.

Even for a water supply scheme, the World Bank finds it difficult to find economic justification. This is much more so in the case of sewerage. In view of the financial limitations, a difficult choice is to be made in deciding what parts of the sewerage system should be implemented first. The question posed is what is the nuisance that could be tolerated with least suffering.

Assuming that the money is made available and the sewers are built, there will be no benefit unless there is an authority that can enforce the building of house connections. In some places it takes 15 or 20 years to make houseowners connect. The law itself is not sufficient, and an effective authority must be set up that will make people connect.

Mr. Rajagopalan then asks what would be the choice when funds are restricted, between providing more water or constructing sewers. To this Mr. Dieterich points out that such very important questions would be for the Government to decide. It is the duty of WHO and the consultants to offer their advice. To this, Mr. Wiener adds that at the present juncture the recommendation would be to provide some initial phases of sewerage next, and more water later.

Mr. Dieterich summarizes the discussion by saying that a statement should be included in the report on the overall aspect of implementation, and an indication as to how the available money should be spent to meet most urgent needs.

E. CONTENTS OF FEASIBILITY REPORT

Before the conclusion of the conference, revised lists of contents for both the engineering and financial parts of the report are tabled (see Appendix). These are accepted as the skeleton for the Feasibility Report, which is to be presented in three volumes. The first volume will contain the general introduction and the engineering report on water supply and sewerage, the second volume will be made up completely of the accompanying drawings, and the third will contain the report on the financial planning of the Scheme.

Regarding the table of contents for the financial report, a suggestion is made by Mr. Corlett that the chapter entitled "Corporation Management" be moved up to position III (instead of VIII), in order to give greater weight to the relevant part of the financial plan. If this chapter is left at the end of the report, he fears that it is likely to be read with less attention.

This suggestion is accepted and will be intimated to PSA (whose representatives have already departed).

Before closing the conference, Mr. Lovelace, who is in the chair, and also Mr. Rajagopalan, Mr. Hagan, Prof. Krul and Mr. Corlett, all express their satisfaction at the successful conclusion of the conference and their confidence that the WHO and the Government of Ghana will find in the Feasibility Report, now to be completed, a firm basis for furthering the work on the Scheme. They express their appreciation to the Consultants for the work done and to T A H A L for its function as host to the conference.

Mr. Wiener, who replies for T A H A L, thanks the speakers for their remarks and expresses gratification at the privilege of having had the conference held in Tel Aviv. The discussions, conducted at a very high level, have made, Mr. Wiener concludes, a valuable contribution to the progress of the Scheme.

APPENDIX

VOLUME I

INTRODUCTION

SUMMARY

A. BASIC DATA

- I. General Background
- II. Population
- III. Economic Development
- IV. Water Requirements

B. WATER SUPPLY

- V. Existing System
- VI. Design Criteria
- VII. Summary of Long-Term Development Programme
- VIII. Source of Supply
- IX. Second Stage Scheme
- X. Second Stage Scheme - Alternative Construction Programmes
- XI. Third Stage Scheme
- XII. Distribution System
- XIII. Cost Estimates
- XIV. Construction Standards and Outline Specifications
- XV. Operation and Maintenance

C. SEWERAGE

- XVI. Existing Sewerage Facilities
- XVII. Oceanographic Considerations
- XVIII. Design Criteria
- XIX. Proposed Project
- XX. Design Population and Sewage Flows
- XXI. Construction Standards and Outline Specifications
- XXII. Labour, Materials and Equipment
- XXIII. Construction Programme and Costs
- XXIV. Alternative Construction Programme

APPENDIX - CONTD.

VOLUME III

FINANCIAL PLANNING

SUMMARY

- I. Existing Conditions
- II. Present Finances
- III. Financial Planning - Water - Design Programme
- IV. Financial Planning - Water - Minimum Programme
- V. Financial Planning - Sewerage - Design Programme
- VI. Financial Planning - Sewerage - Minimum Programme
- VII. Economic Implications

Water Programme

- Rate Impact - Immediate
- Rate Impact - Design Programme
- Rate Impact - Minimum Programme

Sewerage Programme

- Rate Impact - Design Programme
- Rate Impact - Minimum Programme

Combined Impact

- Rate Impact - Design Programme
- Rate Impact - Minimum Programme

VIII. Corporation Management

- Board and Managing Director
- Fiscal Administration
- Planning and Programming
- Personnel - Training and Supervision
- Operations

Note: The Panel has proposed to place Chapter VIII after Chapter II and designate it as Chapter III. However, the final decision is left to the discretion of P.A.S.