REPORT ON

TARIFF STUDY FOR TAIZ WATER AND SEWERAGE AUTHORITY, YEMEN ARAB REPUBLIC VOLUME 1

FOR

UNITED STATES AGENCY
FOR INTERNATIONAL DEVELOPMENT

NOVEMBER 1977

HASKINS & SELLS

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REPORT ON TARIFF STUDY FOR TAIZ WATER AND SEWERAGE AUTHORITY, YEMEN ARAB REPUBLIC VOLUME 1

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SECTION I - INTRODUCTION

1. This report presents the findings of a tariff study for the improved Taiz water and sewerage systems, commissioned by AID contract AID/NE-C-1234, dated 14th May 1976. Volume 1 contains the report on the tariff study and Volume 2 presents the methodology and results of the socio-economic surveys required by the terms of reference for the study, which are set out in Appendix 1 to this volume. The draft report was submitted in sections in February, March, April and September 1977, and discussed in London and Washington in July and September 1977.

TERMS OF REFERENCE

2. Briefly, the terms of reference require us to:-
   (a) review existing data sources and collect additional data to determine the socio-economic characteristics of the population of Taiz and their use of water and sewerage services;
   (b) make projections of pertinent variables to determine the demand for water and sewerage services for the first ten years of operation of the improved systems;
   (c) consider the alternative levels of service that might be offered, their social implications and the administrative problems involved - also concessions that might be made to encourage connection;

(d) evaluate projected cost data provided by the engineering consultants;

(e) make projections of the costs of operating the improved water and sewerage systems during the ten-year period for the various types of service which may be offered;

(f) consider alternative tariff structures, guidelines and policies, including cross-subsidy between different consumer groups;

(g) develop a tariff policy for water and sewerage services, based on projected consumption levels, the ability to pay of different consumers and the type of service provided, which ensures that:-

  (i) all households and other establishments have access to adequate services at the earliest possible time;

  (ii) sufficient revenues are generated to meet the agreed economic rate of return over the ten-year period and to provide for the renewal of the system;

(h) comment on the timing of the introduction of services by geographic area (insofar as it is not constrained by engineering considerations);

(i) prepare annual income statements, cash flows and balance sheets for the ten-year period, showing the annual rate of return on average net fixed assets;

(j) indicate the sensitivity of the results to changed assumptions of revenue and expenditure and comment on the need for review of the tariff recommendations;

(k) examine alternative relending terms and project rates of return for the loan to NWSA, and provide a recommended level for each consistent with the socio-economic and financial requirements of the project;

(l) provide guidance on the criteria and methods to be applied in establishing the eligibility of individual consumers for the various levels of service and rate structures proposed; and for control on the misuse of concessional service.

3. The engineering design cost estimates were much delayed and, when received, were much higher than AID's proposed contribution to the project. The uncertainty inherent in the funding of the remainder of the project increased the complexity of the tariff analysis which was specified and altered the Agency's information requirements. These factors led to discussions with Ms. J. Silver and Mr. P. Guedet of the Agency about modification of the terms of reference.

4. To meet the Congressional time-table AID agreed to delete the requirements to prepare annual financial reports (item (i) in the list above) and to examine alternative relending terms and rates of return (item (k)). In their place we were instructed to base the tariff analysis:-

"on financing terms, a proposed internal rate of return and three alternative debt/equity situations to be provided by the Agency."

(Memo from Ms. J. Silver to Mr. F. Moulton, AID Contract Officer, 30th August 1977 - see Appendix 1A.)

The assumptions adopted are discussed in Section V. The recommended tariff structures presented in Section VIII respond specifically to these revised requirements.

PROPOSED CAPITAL WORKS

5. The main aims of the project are to:-

(a) rehabilitate the existing Kennedy Memorial Water System (KMWS);

(b) increase the amount of water available and improve its quality;

(c) extend the water distribution system so as to cover all existing built up areas (except certain fringe areas at high elevations) and large areas to the north of the city where future development is expected to take place;

(d) provide a wastewater collection and treatment system covering most areas of the town.

6. The principal items to be constructed are:-

(a) a new well field at Al Haima (existing wells at Upper Wadi Houban and Hougfa, and wells being installed by NWSA at Wadis Seena and Salah will continue to be used);

(b) an 18 km 600 mm transmission main between Al Haima and the main yard;
(c) 20 km of primary distribution pipelines;
(d) two storage reservoirs with a capacity of 22,800 cu.m.;
(e) four booster pumping stations;
(f) 50 km of sewerage collection pipelines;
(g) a trickling filtration sewerage treatment plant.

7. It is also proposed to provide as part of the project meters and secondary distribution pipes sufficient to make 4,000 house connections. The installation of these is to be carried out by the KMWS itself and is not included in the project as such.

8. The total annual capacity of the wells is estimated to be 11.5 million cu.m. subject to a margin of error of plus or minus 20%. On the assumption that water losses will be about 20% of output the total amount available for consumption will be about 9.2 million cu.m. per annum.

9. We estimate that the total cost of the project in March 1977 prices will be $44.9 million - $21.9 million for the water system and $23.0 million for the sewerage system. The costs of the project are discussed in more detail in Section V.

10. It is not yet clear how the project will be financed. In our cost projections we have assumed that any loans will bear interest at 5% per annum and be repayable over 20 years with a five year grace period. We have considered the effects of three debt:equity ratios, representing:-

(a) the minimum level of equity ($10 million) which is already committed by AID to the project;

(b) AID's view of the most likely debt:equity mix ($30 million; $15 million);

(c) an all equity option which might come about if the YAR government were to relieve the new authority of all loan obligations in order to meet certain social or welfare objectives in Taiz.

These assumptions are also discussed further in Section V.

STUDY OBJECTIVES

11. The prime objective is to develop a tariff structure for the improved water and sewerage systems which meets:-

(a) certain social and equity needs of the public;

(b) the financial requirements of the utility.

These objectives are discussed in more detail in the following paragraphs. We have supplemented or quantified them as appropriate with information derived from the socio-economic surveys.

Social and Equity Objectives

12. The social and equity objectives set by AID are:-

(a) to provide access to improved services for all households at the earliest possible date;

(b) to encourage connection for a minimum 70% of households to the water service throughout the period, if necessary by offering concessions on connection costs;

(c) to encourage an increase in the proportion of households connected to the sewerage service to 60% by 1987;

(d) to provide public standpipes and lavatories as a minimum level of service for those households without their own connections;

(e) to set the level of charges so that the poorest households are able to afford a satisfactory level of consumption, if necessary by offering concessionary tariffs.

Economic/Financial Objectives

13. The economic and financial objectives are:-

(a) to generate sufficient revenues to provide for the renewal of the system, and to meet the agreed level of loan charges and repayments occurring in the period 1981 to 1990;

(b) to contribute a reasonable sum towards the central overheads of the NWSA; other funds may be made available to NWSA to reduce the overall working capital requirements of the Authority, but should not be used as a form of cross-subsidy between branches.

14. The connection targets and the appropriate levels of consumption per connection which we have projected to meet these objectives are discussed further in Section IV on future demand.

STRUCTURE OF THIS REPORT

15. Volume 1 comprises the following main sections:-

(a) a review of the present levels of service and the demand for those services (Section III);

(b) our estimates of future demand (Section IV);

(c) a review of the engineering design costs (Section V);

(d) the results of the tariff analysis (Section VI);

(e) a discussion on the basis on which we have developed our recommendations and a description of the recommended tariff policy (Sections VII and VIII);

(f) a discussion of the financial and administrative implications of the recommended policy (Section IX).

A summary of our main findings follows this introduction.

16. Volume 2 contains three sections describing the socio-economic surveys of Taiz carried out in July/August 1976:-

(a) a report on methodology;

(b) the results of the household survey;

(c) the results of the business survey.

SECTION II - EXECUTIVE SUMMARY

17. This summary presents the main findings and recommendations of the tariff study for the Taiz Water and Sewerage Authority, commissioned by AID contract AID/NE-C-1234, dated 14th May 1976.

18. The objective set by the terms of reference was to develop a tariff structure which meets:-

    (a) certain social and equity needs of the public;

    (b) the financial requirements of the utility.

Demand Projections

19. We carried out socio-economic surveys of Taiz in July/August 1976 to determine the characteristics of the population and their use of water and sewerage services, and used this data to make projections of future demand for the first ten years of operation of the improved systems.

20. Because of considerable uncertainty about future development in Taiz we prepared three sets of projections based on future growth rates of 6%, 9% and 12% respectively.

21. We identified the likely growth in the number of establishments, the proportion connected to services and growth in the level of consumption per connection for each of the four main markets the Authority serves:-

    (a) domestic;

    (b) institutions;

    (c) industry;

    (d) commercial.

22. Assuming present connection costs remain unchanged, we estimate in our central projections that the total number of connections would increase to:-

	Water	Sewerage
1976	12,000	3,800
1981 minimum	18,100	18,000
1990 maximum	51,500	50,000

23. At the present price of water total consumption would increase to:-

('000 cu.m. per annum)	1976	1981 Minimum	1990 Maximum
Domestic	1,300	2,500	8,900
Institutions	7	13	25
Industry	31	58	137
Commercial	154	267	1,011
Approx. Total	1,500	2,800	10,100

However, uncertainty in the forecasting assumptions means that by 1990 total demand could be between 6.0 million and 16.4 million cu.m. per annum.

Project Costs

24. We estimate the basic capital costs (in 1977 prices), including remedial work to the existing system, well drilling, engineering design costs and costs of the distribution network undertaken by NWSA, but excluding inflation, to be as follows:-

water system	$21,896,500;
sewerage system	$22,986,800;
total	$44,883,300.

These costs were used in our "base case" analysis.

25. We do not agree with the inflation rate assumptions made by Hazen & Sawyer. Firstly we consider that a rate of 10% per annum is too high for foreign costs and suggest an allowance of 8% per annum. Secondly we consider that the increase in local costs is likely to exceed 25% per annum. We

discussed local inflation rates with the Central Bank of Yemen and were told that they envisaged inflation continuing at between 40% and 50% per annum for the next five years.

26. We estimate that, including inflation at the above rates, the total nominal cost of the project will be $71,038,100 - an increase of 58%.

27. It was agreed with USAID that we should review the implications of providing finance for the project in the following three ways:-

    (a) entirely as equity;
    (b) in the ratio 65 debt:35 equity;
    (c) $10 million as equity and the rest as debt.

    We used the central of these assumptions as our base case since AID viewed this as the most likely financial structure.

28. At AID's suggestion we assumed that additional loans would be provided on the following terms:-

    (a) five year grace period;
    (b) repayment over 15 years in equal annual instalments;
    (c) interest at 5% per annum, accrued during the grace period;
    (d) all debt servicing payments due in foreign currency.

29. We estimated the future operating costs of the two systems using a formula provided by Hazen & Sawyer which related costs to our forecasts of the numbers of connections served and (for water) the volume of water consumed.

30. Uncertainty in the loan terms, in the basic capital costs of the systems and in demand means that the revenue required to break even could vary between 60% and 120% of the level forecast in our central projections for the water system and between 84% and 114% for the sewerage system.

Aims of Tariff Policy

31. In determining our recommended tariff structure we have taken into account the following aims:-

(a) to improve health, by increasing the availability of water and flush toilets to encourage improved hygiene and reduce bacteriological disease;

(b) to conserve the available water resources, since the capacity of the current project is limited and would be expensive to extend further;

(c) to increase general welfare, in terms of employment and real income, by making sufficient water available to industrial and commercial consumers to encourage economic development, and by increasing productivity by reducing days lost through sickness;

(d) to redistribute income, by charging a lower tariff to small consumers, often poor households, to encourage at least a minimum level of water consumption; by subsidising the monthly sewerage charge out of water sales revenues; by subsidising the costs of connection for poor households in order to increase the number with satisfactory services; and by providing free public services for poor households who are unwilling or unable to connect;

(e) to generate sufficient financial resources to meet the loan interest and repayment obligations of the Authority, and to provide for the renewal of the system.

Tariff Recommendations

32. We recommend that the water tariff for households, small businesses and institutions (hospitals, schools, etc.) should be (in 1977 prices):-

3 Rials/cu.m. for up to 10 cu.m./month;

6 Rials/cu.m. over 10 cu.m./month;

and that there should be no monthly fixed charge. For manufacturing industry, construction sites and electricity generation all consumption should be at the higher rate.

33. We recommend a stepped tariff structure for water to:-

(a) minimise costs to small consumers (often the poor households);

(b) encourage consumption of a minimum quantity of water;

(c) discourage wasteful use;

(d) contribute to sewerage costs.

34. We believe this tariff is reasonable in relation to present prices, given the greater availability and better quality of water from the improved system, and will reduce present levels of expenditure for poor households at present buying from vendors.

35. We also recommend that the monthly sewerage charge (in 1977 prices) be set at 20 Rials per connection for all consumers; this is less likely to deter use of the service than a charge based on full costs.

36. The base water tariff of 3 Rials/cu.m. covers the full costs of production and protects the Authority from uncertainty in the forecasting assumptions; the 6 Rial higher rate and the step at 10 cu.m. is intended to achieve the maximum possible reduction in the sewerage charge without constraining water consumption for small households and to minimise the total cost of both services for small and medium consumers. Any further steps in the water tariff would reduce the contribution to the sewerage charge and could defer the consumption level at which customers pay the full costs of waste water disposal.

37. Whilst the Authority may wish to defer implementing our tariff recommendations in full until the system improvements are completed, we suggest that some interim increase in water tariffs is desirable to cover the existing production costs, and to reduce the eventual increase from the present level to the recommended level.

38. We also recommend that tariff levels should be revised when tenders are received for the project and financing terms agreed. Thereafter they should be reviewed at least annually, and possibly more frequently if high rates of inflation continue.

Comment on Level of Sewerage Charges

39. At present few households or businesses pay for sewerage service. A charge of 20 Rials/month for the improved service might be a deterrent to connect to the system. We have therefore considered whether further reductions in the level of charge would be feasible.

40. A 5 Rial reduction in the level of charges could be achieved by either:-

(a) reducing the capital costs of the sewerage system by 30%; or

(b) increasing equity funds from $8 million to $16 million, either by increasing the total equity or by diverting equity from the water system; or

(c) paying debt charges of £0.4 million per annum from 1981 to 1990 out of central government, municipality or Taiz Co-operative funds; or

(d) providing additional loans of $4 million to fund 50% of the costs of extending the secondary collection system.

41. We do not know whether such changes are feasible, but if additional funds are required from within Yemen we suggest that changes in the rates and coverage of the existing sales taxes might be considered.

Recommended Concessions on Connection Cost

42. To encourage a high proportion of households and businesses to connect to improved services we propose the following concessions on the cost of connection:-

(a) extended payment plan: payment over two years at 28 Rials/month for water, and 30 Rials/month for sewerage;

(b) concessions to poor households to reduce costs to the same level relative to income as households with average incomes; for example:-

(i) poorest 10%: 100% concession;

(ii) poorest 11% to 20%: 70% concession;

(iii) poorest 21% to 30%:
35% concession;

(c) we also recommend that shared connections should be permitted.

43. These concessions are:-

(a) necessary if a sufficient proportion of households and small businesses are to be connected to achieve the health objective;

(b) a better and more practicable method of helping poor households than concessions on monthly service charges.

44. The introduction of these concessions will require an extension and formalisation of the interview procedures used at present by the Taiz Co-operative to assess eligibility of individual households. We believe that it is possible to form a sufficiently accurate judgement of household incomes in this way, but for administration of the policy to be practicable the number of alternative grant levels should be limited.

Annual Connection Programme

45. To achieve sufficiently high levels of connections to the improved systems to achieve the public health benefits, the Authority should:-

(a) increase the number of water connections by 5,500 between 1976 and 1980;

(b) maintain an annual rate of at least 3,000 water connections between 1981 and 1990;

(c) increase the number of sewerage connections by 10,000 between 1976 and 1981;

(d) maintain an annual connection programme of at least 2,700 sewerage connections between 1981 and 1990.

46. Since not all households will wish, or be able to afford, to connect to improved services, even with the concessions we have proposed, this connection programme includes the following provision of free public taps and toilets in poor areas of Taiz:-

	Taps	Public Toilets
1976	55	46
1981	130	160
1990	190	290

Legislative and Administrative Proposals

47. We recommend that the Authority or the municipality should reinforce the commercial policy outlined above by taking the following action:-

(a) controlling all alternative water sources to ensure that the water supplied is of an adequate quality, and closing those which could be a hazard to public health;

(b) closing all private sewerage systems which do not meet appropriate standards of design or maintenance;

(c) enacting legislation to improve public hygiene, give occupants of rented property or temporary structures access to adequate services and control the wasteful use of water.

48. These actions would require the Authority or the municipality to undertake the regular inspection of alternative water and sewerage systems, and to develop appropriate administrative sanctions (fines, disconnection) to enforce the public health legislation.

SECTION III - PRESENT WATER AND SEWERAGE SERVICES

49. In this section we describe the history and present physical condition of the Taiz sewerage system and the two public water systems - the old system fed by springs on Jabel Sabir, a large mountain range to the south of the city, and the Kennedy Memorial Water System (KMWS). We also present a summary of the key findings of the socio-economic surveys which are likely to affect future demand and our choice of tariff policy.

PUBLIC WATER SYSTEMS

History and Organisation

50. The old spring water system is administered by the Taiz branch of the Ministry of Awkaf (Religious Affairs). The system was built about 700 years ago by the Hassassinat Kings. It originally consisted of open channels which delivered water to the Mosques and small public cisterns. Completely unprotected, the water was not potable.

51. In 1961 USAID financed the installation of pipes to replace the open channels, and the construction of a number of public standpipes. Since then only spasmodic maintenance has been carried out; damage caused by heavy rains in 1975 had still not been repaired a year later.

52. The spring water is untreated and is contaminated by leakages through the pipes. It is, however, preferred by many to KMWS water because it is "sweet" not brackish.

53. To provide more plentiful supplies of potable water to Taiz, and to provide for expansion of the town, USAID commenced in 1962 the construction of a piped water supply system, subsequently named the J.F. Kennedy Memorial Water System. This was based on pumping water from ground wells to the north of the town up to central storage and treatment tanks

in Taiz, and thence into a gravity distrit tion network. The system was designed to supply 3,788 cu.m. a day (150 litres per capita per day) which, as the population was estimated to be between 20,000 and 25,000 and expected to grow only slowly, was considered more than adequate. The construction of the system was completed in 1965. USAID continued to provide technical assistance until April 1967.

54. Management of the system was, until 1975, in the hands of a Director-General, appointed by and answerable to the central government. Funding of capital improvements was provided by the Taiz Co-operative, a local government public works and development agency. Early in 1976, KMWS was taken over by the National Water & Sewerage Authority, which has assumed financial and policy responsibility for the Taiz undertaking in preparation for the major expansion of the water supply and sewerage facilities described in Section I.

Present Physical Condition

55. There are three main problem areas:-

(a) limited water supply;

(b) poor quality water;

(c) inadequate maintenance.

We consider each of these in the paragraphs below.

Limited Water Supply

56. Falling groundwater levels in the original well field caused production difficulties from late 1967 onwards; although the system has been extended with the drilling of new wells and the connection of two new well fields in 1968/69 (financed by the Co-operative), it has not been possible to keep pace with the growth in demand. Based on the results of our survey we estimate that the population of Taiz in mid-1976 was 95,000. This is some four times the population of the city when the system was planned; the growth rate has been much higher than was envisaged.

57. As well as growing in numbers, Taiz has expanded geographically, and the system now has to serve a greater area and reach higher elevations than expected. Supplies are constrained not just by the amount of water available from the wells but by limited pipe, storage and power generation capacities.

58. To ensure that all customers receive water, a system of rationing has been instituted and the transmission pipes to the various areas of the city are open only for one or two hours each day, usually at a regular time. Breakdowns, which are common because the system is so overstretched, can lead to parts of the city being without water for several days at a time.

Poor Quality Water

59. Water is drawn from the aquifer under Taiz. It has a brackish taste and is unpleasant to drink because of the salts (including a significant nitrate content) present in the ground. As waste water penetrates back into the system the concentration of dissolved salts increases.

60. More seriously, rationing, discussed above, causes severe back pressure problems in the distribution and transmission networks. This weakens the joints, and allows seepage into the water supply. There are a large number of cesspit and septic tanks in the city, which are often inefficient. Those built around the existing water mains cause bacteriological contamination.

Inadequate Maintenance

61. Maintenance has been poor due to a lack of trained personnel and proper materials. Maintenance now consists chiefly of repairs to failed facilities rather than prevention of breakdowns by properly planned procedures.

62. The problems of shortage of spare parts and materials have been compounded by the fact that, in order to preserve liquidity, stores have been kept to a minimum. Most items are not replaced until they have been fully run down. A planned preorder system does not exist.

63. All areas of KMWS operations are affected; a significant amount of remedial work will be required before the existing network can be absorbed into the expanded system.

Financial Performance and Policies

64. The financial performance of the Kennedy water system has been poor, with losses in four out of the last five years. This is due to a number of factors, discussed in turn below.

Profitability

65. Profitability is poor because:-

(a) the increase in tariffs has not kept in step with increases in costs of production in an inflationary period (see Table 1);

(b) the shortage of water (aggravated by extraordinary losses in the distribution network) has reduced sales below their potential level without reducing costs by a proportional amount.

66. The worst losses, in 1974, were due to the coincidence of a particularly severe water shortage in a year of high inflation.

Table 1 - Comparison of Tariff Levels, Costs of Production and Water Sales 1972 to 1976

	Average Tariff (Rials/cu.m.)	Average Cost (Rials/cu.m.)	Water Sales (cu.m./Per Annum)
1972	0.76	1.18	1,175,052
1973	0.85	1.25	1,323,968
1974	0.87	1.87	1,252,913
1975	0.96	1.83	1,446,211
Est.1976	2.00	2.60	1,421,000

Notes:

Data derived from sales revenues, costs and water sales in each year; the effective tariffs compare exactly with actual tariff levels except in 1972 when the actual tariff was 0.60 Rials/cu.m.; results for 1976 are estimates based on the first six months.

Cash Flow

67. The effect of these losses on cash flows has been reduced by:-

(a) receipt of extraordinary profits from drilling private wells (significant in 1975);

(b) running down current assets, including spare parts and other supplies (significant in 1974);

(c) grants from central government from 1974 to 1976 to compensate for rapid cost inflation (now terminated).

68. However there are substantial accumulated losses on the Authority's balance sheet which, in our opinion, should be written off as part of an overall financial reconstruction before the new authority comes into being.

Depreciation, End of Service Benefits and Emergency Fund

69. Three balance sheet items also affect the long-term financial viability of the Authority:-

(a) depreciation is currently charged on a straight-line basis on the historic costs of assets, many of which are now life expired, rather than on a renewal cost basis; consequently no reserve exists to provide for the renewal of the system;

(b) the employees' "End of Service Benefit" reserve on the balance sheet is inadequately funded, so that payments are made out of

current sales revenues rather than past profits; moreover, the basis for funding causes a serious drain on current profits in years of high wage increases;

(c) the emergency fund represents outstanding debts to trade creditors of the Authority prior to 1969; these have been frozen by the government but have not been capitalised.

70. These policies should be reviewed in the proposed financial reconstruction of the Authority, and suitable provision made for financing these reserves and also to increase working capital.

Tariff Policy

71. KMWS bills customers monthly. The bill comprises:-

(a) a variable charge for water consumption (based on meter readings) at a standard rate of 2 Rials per cu.m. (3 Rials for industrial consumers and others purchasing water at the tanker filling station at the Kennedy main yard);

(b) a fixed charge (1 Rial) to cover meter maintenance;

(c) sales taxes collected on behalf of the Co-operative (3%) and central government (5%).

72. Those customers whose bills are outstanding at the end of three months are cut off (a sample of 150 accounts in mid-1976 identified 3% over three months old). To be reconnected they must pay the debt and a 10 Rial reconnection charge.

Meters

73. Not all customers are separately metered however. According to our 1976 socio-economic surveys a large proportion (possibly 30%) of customers who had Kennedy water piped into the house either shared a meter, and an account, with another customer, or were illegally connected.

74. Customers buy the meter from KMWS and are responsible subsequently for its maintenance. In cases of meter failure Kennedy estimates consumption on the basis of consumption in the last three periods. There is no penalty charge to encourage replacement.

75. However, recently a very high proportion of meters (Kennedy estimated 25%) have been broken or are life expired, and our sample of accounts identified 54% based on estimated consumption (this includes a few cases where an inside meter was not read for some reason). Attempts by Kennedy to persuade customers to replace their meters met with sufficient customer resistance to force the Authority to abandon its attempt.

76. In addition, complaints from customers have been increasing that meter readings are not accurate, but measure the passage of air trapped in the system rather than water actually consumed. There must now be a significant risk that the Authority is losing potential revenue from water sales, and that its charges are not accurately related to actual consumption.

Connection Policy

77. Connection to the water system is made by the consumer on application to the Kennedy authority and on payment of a connection fee (50 Rials). The fees cover:-

(a) the cost of the meter;
(b) the labour and other costs incurred by the authority in providing the connection to the water main;
(c) technical supervision.

78. The customer is responsible for all costs associated with piping the water from the meter into the building, including the costs of providing a storage tank. (In mid-1976 the Kennedy authority estimated the average total cost of these works at about 300 Rials per connection).

79. In June 1976 Kennedy briefly curtailed the number of connections because of the serious water shortage. This led to a long waiting list of potential customers.

MUNICIPAL SEWERAGE SYSTEM

History and Organisation

80. The Taiz sewerage system, set up in the mid-1960s, is at present owned and administered by the Taiz Municipality. This is headed by the Director-General who is responsible to the Ministry of Municipalities in Sana'a. The sewerage and street cleaning section is headed by an Assistant Director of Engineering (a qualified expatriate engineer) who reports directly to the Director-General.

81. Prior to 1970 the Taiz waste water system consisted of only 0.5 kms (1,500 feet) of sewers, extending from the densely populated Medina area to the Wadi Seena. From 1970 to date the Municipality has extended the system and has plans for further extension. Construction is normally carried out by contractors.

82. There are no waste water treatment facilities. The sewerage is discharged directly into drainage areas at several locations throughout the city. It receives no further treatment other than being sprayed occasionally.

83. It is intended that the system will be taken over by NWSA and will form part of the new authority.

Financial Policy

84. There are no recurrent charges for sewerage services. However, a charge is made at the time of connection to cover a portion of the cost of the main sewer and a permit fee of YR50. As with connection to the water system the householder has to pay a private contractor to make the connection to the main sewer, although the Municipality provide technical assistance. KMWS estimated the average cost of a sewerage connection at about 400 Rials.

85. Should a householder be unable to afford the costs involved he can apply to the Co-operative for assistance. This may amount to as much as two-thirds of the cost.

86. Repairs to the main sewer are the responsibility of the Municipality, and are carried out by its own personnel. When maintenance is required to a connection, notice is given to the householder who is warned that if repairs are not carried out within a week then:-

(a) his water will be cut off;
(b) the work will be carried out by the Municipality and charged to the householder.

87. No records are kept of sewer maintenance, but 3,600 Rials per month is currently budgeted. The costs of construction of the system have been charged against revenue in the year in which they occurred.

SUMMARY OF DEMAND AND SUPPLY

88. The following paragraphs summarise the main findings of our socio-economic surveys of households and businesses in Taiz in mid-1976 as they relate to present demands for service from the water and sewerage systems. Each survey is discussed in turn; paragraph references are to the respective survey reports (March and February 1977).

HOUSEHOLDS

Characteristics of the Survey Population

89. We estimate the total population in Taiz was about 95,000 in June 1976, representing a 10% per annum growth since the national census (paragraphs 44 and 47).

90. The population was young, which led to a low death rate (ten per 1,000), and a high birth rate (30 to 35 per 1,000) which may be expected to increase as the proportion of women of child-bearing age increases (paragraphs 48, 51 and 52).

91. The key factor affecting the growth of Taiz is immigration, which has been several times the rate of emigration and the rate of net natural increase. The average net inflow over the past two years was 69 per 1,000 population (paragraph 64).

Household Incomes and Expenditure

92. 49% of households depended solely on incomes from employment, and 19% depended solely on incomes from other sources - mainly the government, relatives outside Taiz and an unidentified source (paragraph 76).

93. Mean real income was 1,130 Rials per month per household and 255 Rials per month per head ($250 and $57 respectively), compared with mean household expenditure of 915 Rials per month ($200) (paragraphs 76 and 81 and Table 12).

94. However, poor households were more likely to overspend their income than rich households (paragraph 84).

Water Consumption and Expenditure

95. The main water sources are:-

(a) the Kennedy Memorial System, which served 78% of households or more;

(b) free sources (wells, taps, mosques) which served 20% of households;

(c) another unidentified source which served 12% of households;

(d) the Jabel Sabir piped system and water carriers (13%).

96. Consumption per head varied from 33 litres per capita per day for households without a connection to Kennedy to 51 l/c/d for households with a basic connection and 58 l/c/d for households which also had a flush toilet. These figures reflect the inadequacy of the present supply, particularly for households with more than the basic connection (Table 25).

97. Water was one of the smaller items of household expenditure - average expenditure on water was 18 Rials/month. However, poor households spent a higher proportion of their income (4%) on water than rich households (2%). The data collected suggests an income elasticity of demand of about 0.5 (paragraphs 116 and 117).

Adequacy of Supply

98. A relatively high proportion of households expressed dissatisfaction with the service offered, whichever source was used. The main reasons were the same: the water supply was limited, and many households had inadequate storage (Table 22).

Attitudes to an Improved Kennedy System

99. Only 17% of households not already connected were willing to connect to an improved Kennedy System. Two significant groups, those in rented accommodation and poorer households, were not willing to connect (paragraphs 151 to 153).

100. Responses to hypothetical questions about consumption from an unrestricted water supply showed that households anticipated an immediate increase of 20% to 25% in consumption. Household demand was not very sensitive to price increases (the average price elasticity of demand was 0.15) (paragraph 165).

Present Sewerage Services

101. 86% of households had their own toilet; although the type of toilet varied depending on whether the main sewerage service was available. Only 26% had a connection to the municipal sewer (paragraph 181).

102. The proportion of households with their own toilet increased with household income and size (paragraph 183).

103. The majority of households without their own toilet defecated upon the ground; the proportion of such households was highest in poor areas on the outskirts of the town (paragraph 182).

104. The majority of households paid nothing for sewerage disposal, whatever type of facility they used (paragraph 186).

Connection to an Improved Sewerage Service

105. Half of the households not already connected would be willing to connect to an extended sewerage system. These were more likely to be large, rich households which owned their own home, whilst small, poor households and those in rented accommodation were less willing to connect (paragraphs 195 and 196).

106. Two significant groups were not willing to connect - tenants, and some households stating that connection was too expensive (paragraphs 199 and 201).

BUSINESSES

Characteristics of Businesses

107. We estimate the total number of businesses in Taiz in July 1976 was approximately 3,800, employing approximately 12,500 persons (paragraph 7).

108. These were small, predominantly young, businesses. The majority were shops, small restaurants and workshops. Average turnover was 2,100 Rials ($500) per month, and few businesses were very profitable (paragraphs 8 to 12).

Water Consumption and Expenditure

109. Over half the businesses used KMWS, 45% having their own connection and 11% sharing a neighbour's. The only other significant sources were water carriers (12%) and some other unidentified source (12%) (paragraph 21).

110. 40% of businesses used no water; the remainder used on average 7½ cu.m. per month from all sources. Average expenditure on water was less than 1% of turnover, equivalent to less than 4% of profits (paragraphs 16 and 19).

111. Only 61% of Kennedy users were satisfied with the present level of service; water shortage was the main reason for dissatisfaction, although this was aggravated by a significant number of businesses with insufficient storage. More than 25% of Kennedy users supplemented their consumption from water carriers or another source (paragraphs 24 and 25).

Attitudes to an Improved Kennedy System

112. Half of those businesses not at present connected to Kennedy stated they would be willing to connect to an improved system. However, knowledge of connection cost was poor, so this proportion might fall as information about cost improved (paragraphs 49 and 50).

113. Some of those not wishing to connect were tenants. But the majority not wishing to connect stated they did not need a connection; they may be some of those businesses which use no water at all (paragraphs 52 and 53).

114. Businesses anticipated that relaxation of the supply restriction might lead to an increase in consumption of an average of 15% to 20% at present prices (paragraph 56).

115. If the price were doubled the benefits of providing an unrestricted supply would be wiped out for over half the businesses connected to the new system. This implies an elasticity of demand to price increases of between 0.1 and 0.2 (paragraphs 60 and 63).

Existing Sewerage Services

116. Only 38% of businesses had their own toilet on the premises. 23% had flush toilets connected to the municipal sewer; the remainder had septic tanks and cesspits. Of the 62% of businesses without their own toilet, 60% (37% of the total interviewed) used a public toilet or a toilet in neighbouring premises (paragraphs 65 to 67).

117. The majority of businesses stated that they paid nothing for sewerage services. A few of those businesses without a toilet paid a small charge for the toilet they used (paragraph 72).

Connection to an Improved Sewerage Service

118. Half of those at present without a sewer connection stated that they would be willing to connect to the extended system; this includes half of the businesses at present having no toilet (paragraph 78).

119. The cost of connection was not recognised as a major problem. However, 74% of businesses did not know the cost, and with better information more might be deterred by it (paragraph 82).

SECTION IV - FUTURE DEMAND FOR WATER AND SEWERAGE SERVICES

120. This section discusses our demand projections for improved water and sewerage services. Each of the four main markets are discussed under the following headings:-

(a) domestic;
(b) institutions;
(c) industry;
(d) commercial.

Within each market we discuss first the likely growth in the number of establishments, then the future proportions connected to improved services and finally growth in the level of consumption per connection.

121. Because of considerable uncertainty in the information we collected about future trends in Taiz, we have prepared three sets of projections - a central projection and higher and lower alternatives. The section concludes with a discussion of how these are used in our tariff analysis.

122. Demand projections for the two largest markets (domestic and commercial) are based on data from our socio-economic surveys of households and businesses in Taiz; these are reported fully in our survey reports (March and February 1977), and key results are summarised in Section III. Institutional and industrial demand projections are based on data collected in direct interviews with government departments and industrial enterprises in Taiz and Sana'a, and from examination of KMWS customer records (see Appendix 3 for list of interviews).

DOMESTIC DEMAND

Growth in Market Size

123. The growth in the number of households is determined by:-

(a) growth in population;
(b) change in household size.

124. From the survey we estimate that the growth in population in 1974/75 and 1975/76 was as follows:-

net natural increase : between 2% and 3% per annum;

net immigration : between 4% and 10% per annum.

The rate of migration was particularly unstable because of changing economic and political factors.

125. Since there will be a significant increase in the number of females of child-bearing age up to 1990, we expect that the rate of NNI could increase by up to 1%. If the rate of immigration remains constant, the rate of population increase could be between 7% and 14% per annum. Alternatively, if the level of immigration remains constant, average population growth might fall from between 7% and 10% in 1981 to between 6% and 8% in 1990.

126. As a check on the appropriateness of these figures for forecasting we estimated the long-term growth in population since 1962, when Ruiz estimated the Taiz population as 20,000 (initial Taiz water supply system design report). The average annual growth rate up to 1976 was 11%, which is very similar to the short-term change between the YAR Census (January 1975) and our surveys (July/August 1976).

127. However, this period is characterised by the rapid inflow of population from the surrounding rural areas, and by major population shifts from Aden in 1969 and 1972. We believe it is unlikely that migration will continue at this rate up to 1990, and have therefore adopted a lower rate for our population growth projections. Our three alternative growth assumptions are:-

(a) low: 6% per annum;

(b) central: 9% per annum;

(c) high: 12% per annum.

128. Changes in household size are much more difficult to estimate. Since the change between the YAR Census estimate (6.2 persons/living quarter) and our survey estimate (5.8 persons/household) is small, and could be the result of differences in definition,

we have assumed that the average household size remains constant at 5.8 persons up to 1990. If this assumption is wrong it is more likely to affect the numbers of connections required rather than the level of consumption.

129. These assumptions imply the following growth in population and households:-

	Population			Households		
	(a)	(b)	(c)	(a)	(b)	(c)
1976	84,000	84,000	84,000	14,500	14,500	14,500
1981	109,000	129,000	148,000	18,700	22,300	25,500
1985	137,000	183,000	233,000	23,700	31,500	40,200
1990	184,000	281,000	411,000	31,700	48,500	70,900

Proportion Connected to Services

Household Connections

130. From the socio-economic surveys we estimate that 71% of households were connected to water service in 1976 and 26% to sewerage service. When asked about willingness to connect to improved services 76% indicated interest in water service and 65% in sewerage service (including those already connected). These proportions assume that connection costs do not change significantly from present levels.

131. Because water service is already almost universally available, we have assumed that the minimum proportion likely to connect to water in the future is unlikely to be higher than the proportion already connected (70%). However, because the sewerage service is available only in a very limited area, we have assumed the minimum proportion likely to connect to sewerage in the future (assuming present cost levels) is given by the proportion expressing willingness to connect (65%). (See also paragraphs 404 - 410).

132. For both water and sewerage we analysed the reasons given by households which were not willing to connect, and have attempted to identify a proportion which might be willing to connect at a later date, when improved services are in operation and attitudes are likely to change. These maximum connection rates we have estimated as 90% and 80% respectively. (The sewerage connection figure could be lower if existing private systems are permitted to remain.)

133. For the different forecast growth rates the projected numbers of connections are therefore as follows:-

	Water		Sewerage	
	1981 min.	1990 max.	1981 min.	1990 max.
(a) low	13,100	28,500	12,100	26,900
(b) central	15,600	43,600	14,500	41,200
(c) high	17,900	63,800	16,600	60,200

134. This compares with 10,300 household water connections and 3,100 sewerage connections in 1976 estimated from our socio-economic surveys. A programme of 2,800 water connections and approximately 2,600 sewerage connections would be necessary each year from 1981 to 1990 to achieve the level of connection assumed in our central projections. This compares with a current annual rate of about 800 to 1,000 water connections (the sewerage connection rate is unknown).

Free Public Services

135. For the remaining proportion of households who will not have their own connection to water or public sewerage services we have assumed that a public standpipe and lavatory will be provided in poor areas (i.e. where household connections are scarce) at a minimum rate of one per hectare, or at a rate of one per 25 dwellings in more densely built-up areas, and in other public places. (These standards represent a maximum walking distance of approximately 50 metres to the public services - which is the maximum distance

householders travel at present, and an equivalent level of service in above average density areas. Whatever standards the Authority adopts should be reviewed regularly and the number and location of public services varied according to need.)

136. Clearly it will not be possible to serve all households without their own connections from public standpipes and public lavatories; many of them will be widely dispersed, some in predominantly middle income areas. It might be more cost effective to offer these households a concession on connection costs rather than attempting to provide a free service which might be misused.

137. We have assumed that the free service is used by 50% of households without their own connection in 1976 and 1981, and by 100% of such households in 1990 (when the maximum proportion of households may be connected). In our central growth case the following number of public taps and lavatories would be required. In addition, a small number may be required in public places in the city:-

	Taps	Lavatories
1976	80	220
1981	130	160
1990	190	290

This compares with 55 public taps and 46 public lavatories actually available in 1976.

Consumption per Connection

Household Connections

138. Our socio-economic surveys established levels of household consumption of Kennedy water, and identified variations according to household size and whether a household possessed a flush toilet. They also indicated that an average 20% increase in consumption was anticipated from the unconstrained supply.

Table 2 - Growth in Water Consumption per Head

	Litres per Head per Day (l/c/d)
1. Survey Estimates 1976	
(a) households with bath only	50.8
households with bath and flush	57.5
weighted mean: present 64% with flush	55.1
maximum 95% with flush	57.2
(b) estimated increase from improved supply	20%
2. Forecast 1981	
(a) present % with flush + 20% + 1½% to 2% per annum (1976 to 1981)	72
(b) maximum % with flush + 20% + 1½% to 2% per annum (1976 to 1981)	75
3. Forecast 1990	
(a) present % with flush + 1½% to 2% per annum (1981 to 1990)	84
(b) maximum % with flush + 1½% to 2% per annum (1981 to 1990)	88
(c) present % with flush + 3% to 4% per annum (1981 to 1990)	98
(d) maximum % with flush + 3% to 4% per annum (1981 to 1990)	102

Note: The central projection (paragraph 131) suggests the following increase in average household consumption from all sources:-

1976	9.6 cu.m./month
1981	12.5 cu.m./month
1990	16.2 cu.m./month

139. Table 2 summarises our calculation of average consumption per head (at the present price of water) and indicates the sensitivity of the estimate to different assumptions about ownership of flush toilets and secular growth in consumption (reflecting changes in attitudes and preferences). The three alternative projections we have adopted for connected households are:-

(l/c/d)	1981	1990	1990/ 1981
(a) low	72	86	+20%
(b) central	72	93	+30%
(c) high	72	100	+40%

Free Public Services

140. For households obtaining water from public standpipes, the socio-economic surveys indicate that consumption in 1976 ranged from eight to 25 litres per head per day according to household size and distance from the tap. We assume that this would rise to ten to 30 l/c/d from the improved supply (i.e. increase by 20% as for connected households), and increase slowly over time.

141. On average therefore we have assumed a consumption level of 24 l/c/d from standpipes in 1981 and 31 l/c/d in 1991 - that is, one-third of the per capita consumption level in our central projection for connected households.

142. Assuming a totally unconstrained water supply, and no change in the unit price of water or cost of connection, our central projections imply the following levels of domestic water consumption from the improved system:-

1976 1,300,000 cu.m. per annum;
1981 2,500,000 cu.m. per annum;
1990 8,900,000 cu.m. per annum.

The proportion of free water to public standpipes would fall from about 6½% in 1976 and 1981 to about 3½% in 1990.

INSTITUTIONAL DEMAND

143. This market comprises the following types of establishment:-

(a) schools (including school boarding houses);
(b) hospitals;
(c) government offices;
(d) mosques;
(e) barracks.

From our surveys and direct interviews we estimate there were 5,000 persons resident in these institutions in 1976.

Growth in Market Size

144. The growth in the size of this market is partly related to the rate of population growth (schools, government offices, mosques), and partly to changes in the standard of provision (schools, hospitals, and public lavatories).

145. In no case were we able to identify firm plans for the development of additional establishments in Taiz for the period up to 1990; to a large extent the timing and type of development is at the discretion of foreign aid donors.

146. We therefore developed our own assumptions on the basis of the interviews we undertook and, as far as possible, discussed their validity with appropriate officials in Yemen. Our estimates are summarised in Table 3 and discussed briefly below.

Schools

147. At present there are 36 schools in Taiz with children enrolled. This is substantially fewer than the number of children of school age (estimated from the socio-economic surveys), and reflects:-

(a) the very low proportion of females receiving education at all levels;

(b) the low proportion of males receiving secondary level education.

148. We have assumed that, by 1990, the proportion of children attending school at all levels will increase, as follows:-

primary	to 90% of all children;
preparatory	to 50% boys, 30% girls;
secondary	at 9% per annum.

If the average size of school is unchanged, these standards imply an increase in the number of schools with our central population projections to 50 in 1981 and 90 in 1990.

Hospitals

149. With the opening of the new Revolution hospital in Taiz in August 1976, and the resulting shift of staff and functions between the older establishments, Taiz now has four hospitals with a combined total of 1,083 beds. This represents a much higher level of provision per head of population than elsewhere in Yemen because Taiz acts as a centre for the surrounding region.

150. Whilst there seems little likelihood of additional facilities being required in the immediate future, we have allowed in our forecasts for one additional hospital in the mid-1980s to maintain standards of health care as Taiz expands.

Table 3 - Estimated Numbers of Institutions 1976 to 1990

	1976	1981 (a)	1981 (b)	1981 (c)	1990 (a)	1990 (b)	1990 (c)
Schools	36	46	50	54	60	90	120
Hospitals	4	4	4	4	5	5	5
Government Offices	8	11	11	11	20	20	20
Mosques	30	36	36	36	47	52	58
Barracks	16	16	16	16	16	16	16

Note: These assumptions imply an average annual growth in the total number of institutions of 3%, 4½% and 6% respectively.

Government Offices

151. At present in Taiz there are eight government or municipal offices - representing government departments (excluding the electricity, water and highway authorities). With the rapid growth of the town, and the probable increasing complexity of administration, we think it is likely that the number of government officials will increase at least as fast as the population for several years. We have assumed an increase in the number of establishments to 11 in 1981 and 20 in 1990.

Mosques

152. There were 53 mosques in Taiz in 1976, although only 30 were connected to the Kennedy system. We have assumed that the number of mosques will increase less than half as fast as the rate of increase of the population, but that all of the new ones will receive Kennedy water. Our projections are for 59 mosques in 1981 and 70 in 1990.

Barracks

153. In 1976 there were 16 permanent establishments in Taiz housing military or police personnel. Ordinarily, only those forces responsible for police duties would be likely to increase with the growth of the town. We were unable to establish this figure, but believe it to be small. We have therefore assumed that the total number of establishments remains unchanged up to 1990.

Proportion Connected to Services

154. In 1976 all of the establishments identified above received water from the Kennedy water system, with the exception of some mosques which received water from the Jabel Sabir system or from wells. We assume that all new establishments will be connected to the improved system from their beginning.

155. Most of the institutions have flush toilets connected to the sewerage system, although the older establishments and those on the outskirts of the city have private systems of varying standards of acceptability. We assume that all new establishments will be connected as they are built, and that existing private systems will be converted as the sewerage system is extended.

Consumption per Connection

156. Average water consumption on a per capita basis was very low in all the institutions; it was partly constrained by supply limitations, and partly reflects low standards of public hygiene.

157. We have adopted three alternative forecasts of future consumption to match, as nearly as possible, the projections adopted for domestic consumers:-

(a) in the low and central cases we have assumed that only the worst standards, in schools and hospitals, are improved;

(b) in our high projection we have also assumed that consumption in government offices rises to the same level as consumption in private offices, and that there is a secular growth in consumption for other establishments following the trend projected for households.

158. The detailed assumptions for each type of institution are summarised in Table 4. On the assumptions we have made in our central projection, the combined demand for water for institutions would be:-

1976 7,000 cu.m. per annum;
1981 13,000 cu.m. per annum;
1990 25,000 cu.m. per annum.

Table 4 - Growth in Water Consumption: Institutions

	Low	Central	High
Schools	Increase to highest 1976 level per head	1976 best + 50% by 1990	1976 best + 100% by 1990
Hospitals	Increase consumption by 1990 to level per bed in Swedish hospital		
Government offices	Constant 1976 level	Constant 1976 level	1976 + 80% to level in private offices
Mosques	Constant 1976 level	Constant 1976 level	Constant 1976 + 20%
Barracks	Constant 1976 level	Constant 1976 level	Constant 1976 + 20%

Note: These detailed assumptions imply a real growth in total institutional demand of 20%, 30% and 40% respectively between 1981 and 1990.

159. Because institutions represent only a small proportion of total demand, the accuracy of the detailed assumptions we have made in this section are not critical to our tariff analysis.

INDUSTRIAL DEMAND

160. We have included in this market sector only the largest manufacturing establishments in Taiz. Smaller workshops (employing less than ten persons) are included in the commercial market sector discussed in the next section. In total we estimate from our surveys and interviews that some 8% to 10% of the working population were employed in this sector - that is some 1,600 persons in 1976.

Growth in Market Size

161. Taiz is a small but steadily growing industrial centre in Yemen, with important factories producing biscuits, soft drinks, plastic and leather goods and printing for the whole country, and smaller establishments supplying metal and concrete products to a more local market.

162. We visited 19 factories and government offices to discuss possible industrial growth in Taiz up to 1990. None of the companies we visited, or the government departments responsible for industrial development, had firm ideas for the period beyond the end of the present five year plan. However it seems certain that industry will continue to grow for the foreseeable future and the rate of development may increase faster than the rate of growth of population, both because of Yemen's overall economic development and because of the relative advantages of Taiz over other towns.

163. We have assumed three alternative growth patterns for industrial employment, which reflect alternative assumptions about the rate and type of industrial development which may occur. These are:-

(a) low case: + 15% per annum 1976 to 1980;

+ 10% per annum 1981 to 1985;

+ 5% per annum 1986 to 1990;

(b) central case: + 15% per annum 1976 to 1980;
+ 10% per annum 1981 to 1990;

(c) high case: + 20% per annum 1976 to 1980;
+ 10% per annum 1981 to 1990.

These growth rates compare with our assumed rates of population increase of 6%, 9% and 12% respectively.

Proportion Connected to Services

164. Many of the factories in Taiz are located outside the present areas served by the public water supply or sewerage systems. They rely for water supply on tanker trucks delivering water from the Kennedy yard (e.g. the soft drinks bottling plant), or on private wells (the biscuit factory rents a well from Kennedy that is not at present used for the city water supply). These are expensive alternative sources. Similarly, toilet facilities are mainly private systems (septic tanks and cesspits).

165. As the water service is improved the phase 1 service area will be extended to cover more of the eastern industrial estate (along the Sana'a road), and will therefore provide piped service for a greater proportion of industrial demand, depending on where development takes place.

166. We assume that industrial water consumption is not at present constrained by shortage of supply. However as the industrial sector grows, supplementary water sources will become less able to meet any shortfall in the public supply. Demand for water from KMWS can therefore be expected to grow whether or not there is real growth in consumption.

167. At present KMWS meets only 20% of industrial demand from the piped water supply. We have adopted the following assumptions in projecting future demand:-

(a) KMWS supplies 50% of industry total;
(b) KMWS supplies 80% of industry total;
(c) KMWS supplies 100% of industry total.

Consumption per Connection

168. Present levels of consumption vary considerably according to the type of industry. Nevertheless, except for the soft drinks bottling plant, consumption per employee in 1976 and anticipated consumption for the next year were constant.

169. In our low and central assumptions we have estimated future demand at the present average rate per employee; in our high case we have assumed a 5% increase in consumption per head, reflecting the fall in costs of KMWS water compared with present private and supplementary sources.

170. In our central projections the number of connected establishments will rise from ten in 1976 to 19 in 1981 and 45 in 1990. Total industrial consumption on these assumptions will be:-

1976 31,000 cu.m. per annum;
1981 58,000 cu.m. per annum;
1990 137,000 cu.m. per annum.

Since industrial demand is small as a proportion of total demand, the accuracy of the assumptions we have made are not critical to our tariff analysis.

COMMERCIAL DEMAND

171. This market includes all the categories of small businesses interviewed in our business survey:-

(a) shops (2,250);
(b) restaurants and coffee shops (410);

(c) workshops (510);
(d) offices (155);
(e) lodging houses (20);
(f) miscellaneous businesses (410).

From the survey we estimate there were 3,800 such establishments in Taiz in 1976, employing 10,700 persons.

172. In addition, we include information about hotels which was collected in our programme of direct interviews. There were four class I and 15 class IV hotels in Taiz in 1976.

Growth in Market Size

173. The growth in the size of this market is partly related to population growth and partly to changes in real income.

174. We have assumed that all types of businesses except restaurants, coffee shops and hotels will grow at the same rate as the population. This implies that there will be no increase in the per capita demand for most trades on services.

175. Taiz is already well supplied with restaurants and coffee shops and we believe it is unlikely that a larger population would automatically generate sufficient additional business to support a proportionate increase in the number of such establishments.

176. As for hotels, Taiz is not a major tourist centre in Yemen, and we would expect the expansion of the tourist trade to be at a lower rate than the increase in population.

177. We have therefore assumed the following changes in the total number of businesses:-

(a) low case: + 5% per annum (1976 to 1990);

(b) central case: + 7½% per annum (1976 to 1990);

(c) high case: + 10% per annum (1976 to 1990).

(This compares with our population assumptions of 6%, 9% and 12% per annum.)

178. These assumptions imply the following number of establishments:-

	1976	1981	1985	1990
(a) low case	3,800	4,500	5,700	7,500
(b) central case	3,800	5,500	7,200	10,800
(c) high case	3,800	6,000	9,200	15,800

Proportion Connected to Services

179. From the business survey we estimate that 45% of businesses were connected to the Kennedy water system in 1976, and a further 27% expressed willingness to connect. The proportion connected or willing to connect varied between virtually all the offices, restaurants and lodging houses, and two-thirds of the shops, workshops and miscellaneous businesses. All the hotels were connected.

180. Only 23% of businesses were connected to the municipal sewerage system, but an additional 39% expressed willingness to connect. In total, the proportion connected or willing to connect varied between two-thirds of shops, offices and lodging houses, and under a half of restaurants, workshops and miscellaneous businesses. All hotels were connected.

181. We analysed the reasons given by businesses for not wishing to connect to the water and sewerage systems, and estimate that the connection rates might reach 85% and 80% respectively when the systems are in operation and tastes change. (These estimates are based on the present cost of connection.)

182. We have based our projections on the following connection targets, assuming that the present level of water connections is the most reliable guide to future behaviour; we have adopted the proportion willing to connect to sewerage as our base estimate because at present connections are constrained by the limited availability of the sewerage service:-

	Water	Sewerage
1980 minimum	45%	60%
1990 maximum	72%	80%

183. This implies a connection rate of some 600 water and 600 sewerage connections each year from 1981 to 1990 to meet our central demand projections.

Consumption per Connection

184. Our survey of businesses established that the present average consumption of Kennedy water was 7.5 cu.m. per month per establishment. This was higher in restaurants and lodging houses, and lower in shops. High proportions of shops, workshops and miscellaneous businesses used no water at all.

185. The survey identified that the average level of consumption was constrained by the present shortage of water, and that consumers anticipated a 20% increase in supply from the improved system.

186. In projecting future demand we have adopted the following alternative assumptions:-

(a) low case: constant consumption at the 1976 level + 20%;

(b) central case: consumption increasing from the level of the low case in 1981 by an additional 20% by 1990;

(c) high case: consumption increasing from the level of the low case in 1981 by an additional 30% by 1990.

The central and high assumptions represent a secular increase in demand reflecting a change in consumer tastes similar to that projected for households.

187. In total our central assumptions imply the following change in total commercial demand during the forecast period:-

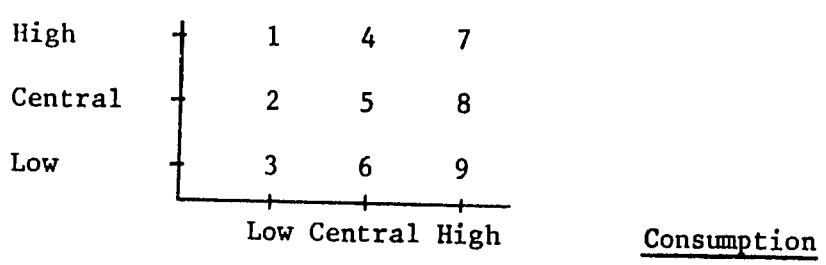
1976 154,000 cu.m. per annum;
1981 267,000 cu.m. per annum;
1990 1,011,000 cu.m. per annum.

USE OF PROJECTIONS IN TARIFF ANALYSIS

188. We have developed alternative assumptions about the growth in numbers of connections and growth in consumption per connection for each of the main markets served by the water and sewerage systems. These we have identified separately as our:-

(a) low case;
(b) central case;
(c) high case.

189. It would be possible to combine these two sets of assumptions in nine ways:-



190. In the tariff analysis described in Section VI we have adopted the central connection and central consumption assumptions (point 5 in the diagram above) in our "base case" demand projections. We have tested the sensitivity of our tariff calculations to changes in demand representing the following alternative combinations of assumptions:-

(a) high connections, low consumption (point 1 in the diagram);

(b) low connections, low consumption (point 3);

(c) low connections, high consumption (point 9).

191. We do not consider a high connection/high consumption case is worth presenting; since the demand at the end of the forecast period would significantly exceed the available supply, severe rationing would need to be introduced in the mid-1980s.

SUMMARY OF KEY ASSUMPTIONS

192. The following tables summarise the key assumptions of our demand projections for each of the main market sectors:-

(a) Table 5 shows the growth in market size;

(b) Table 6 shows the level of connection to water and sewerage services;

(c) Table 7 shows the growth in water consumption.

Table 5 - Assumed Growth in Market Size

(1981 to 1990)

	Low Growth	Medium Growth	High Growth
Domestic	+ 6% per annum	+ 9% per annum	+ 12% per annum
Institutions	+ 3% per annum	+ 4½% per annum	+ 6% per annum
Industry	+ 10% per annum (1981 to 1985) + 5% per annum (1986 to 1990)	+ 10% per annum	+ 10% per annum
Commercial	+ 5% per annum	+ 7½% per annum	+ 10% per annum

Table 6 - Assumed Connection Rates

	Water	Sewerage
Domestic	70%-90%	65%-85%
Institutions	100%	100%
Industry	80%	80%
Commercial	45%-72%	60%-80%

Source: Socio-Economic Surveys of Taiz, 1976.

Notes: (1) For water the lower figure is the present proportion connected, whilst for sewerage it is the proportion stating willingness to connect; in both cases the higher figure is our estimate of an ultimate connection level based on an analysis of the reasons given for not wishing to connect.

(2) The water and sewerage connection rates were collected independently in the surveys, so that there is some inconsistency in the proportion connecting to the sewerage service but not to water. In Section VIII we have assumed that sewerage connections do not exceed 85% of water connections.

Table 7 - Assumed Growth in Water Consumption

		Low Growth	Medium Growth	High Growth
Domestic:	connected	1981 + 20% + 20% over ten years	1981 + 20% + 30% over ten years	1981 + 20% + 40% over ten years
	not connected	1976 + 20% + 30% over ten years	1976 + 20% + 30% over ten years	1976 + 20% + 30% over ten years
Institutions		1976 + 20% + 20% over ten years	1976 + 20% + 30% over ten years	1976 + 20% + 40% over ten years
Industry		No change	No change	1976 + 5%
Commercial		1976 + 20%	1976 + 20% + 20% over ten years	1976 + 20% + 30% over ten years

193. In our central case, 3,700 water and 3,600 sewerage connections would need to be made each year from 1981 to 1990 to connect all those households and businesses which we anticipate will wish to connect (assuming present connection costs remain unchanged). This would increase the total number of connections to:-

	Water	Sewerage
1976	12,000	3,800
1981 minimum	18,100	18,000
1990 maximum	51,500	50,000

(In practice the number of sewerage connections might be lower if some private systems are permitted to remain.)

194. At the present price of water total consumption would increase to:-

('000 cu.m. per annum)	1976	1981 Minimum	1990 Maximum
Domestic	1,300	2,500	8,900
Institutions	7	13	25
Industry	31	58	137
Commercial	154	267	1,011
Approx. Total	1,500	2,800	10,100

(If the maximum proportion connected, there would be a shortage of water from the improved system in about 1990 compared with our central demand projections.)

SECTION V - PROJECT COSTS

INTRODUCTION

195. In this section we explain the assumptions underlying the cost estimates used in the tariff analysis. The section deals separately with capital, operating and connection costs.

196. The cost estimates are based primarily on information received from Hazen and Sawyer the consulting engineers responsible for the project design though, where possible, we used information which we ourselves collected in the Yemen as a check on Hazen and Sawyer's costings.

197. Our main sources of information were:-

(a) Hazen and Sawyer's preliminary report, dated March 1977;

(b) a series of telexes starting with a long telex dated 26th May which updated some of the March cost estimates and supplied certain additional information which we had requested through AID/Sana'a.

198. As far as possible we discussed the assumptions adopted with USAID staff members.

CAPITAL COSTS

Construction Costs

199. In the table below we have set out Hazen and Sawyer's revised estimates of the capital cost of the project according to the 26th May telex:-

	$000s		
	Local Costs	Foreign Costs	Total
Water supply system	6,176	6,950	13,127
Sewerage system	13,194	4,617	17,811
Contractors' mobilisation	815	2,185	3,000
Supervision of construction	1,500	2,300	3,800
Contingencies	1,940	1,157	3,097
Escalation allowance	12,785	1,157	13,942
Vehicles and equipment	-	700	700
Land/rights of way	770	-	770
Total	37,181	19,066	56,247

200. The contingency allowance shown above is 10% of basic water and sewerage system costs. If, however, escalation is included the allowance falls to 6.0% of local costs and 9.1% of foreign costs.

201. The basic water and sewerage system costs shown above exclude a number of items which we consider should properly be included in "project costs"; these items and Hazen and Sawyer's estimate of their basic cost (in U.S.$000s) are:-

(a) remedial work on parts of the existing system to be kept in use following completion of the project - 744.9;

(b) well drilling - 1,700.0;

(c) project design - 998.7;

(d) work on the secondary water distribution network to be undertaken by the NWSA itself - 797.6;

(e) training - 250.0 if Taiz shares in a national programme; 500.0 if completely separate programme.

202. Hazen and Sawyer's project costs include house sewerage connection costs which will be recouped from householders; similarly they include materials for house water connections (but not the installation costs since this work is to be undertaken by the NWSA).

203. We calculated the basic capital costs to include all these items except training and house connection costs. House connection costs were excluded since they would be met by householders and not require financing (though we did allow for the different phasing of costs and receipts in calculating the build-up of debt servicing obligations). Training was excluded on the grounds that it would be financed partly by technical assistance in grant form and partly out of operating revenues of the existing system during the construction period. We included a 10% contingency allowance on all items except mobilisation payments, supervision of construction, vehicles and land and rights of way.

204. Recalculated in this way the capital costs excluding inflation amount to $44,883,300 of which $21,896,500 are water system costs and $22,986,800 sewerage costs. These costs were used in our base case. (The treatment of inflation is described in more detail at paragraph 214).

205. As a high cost case, we used the base case costs (including contingencies) plus an extra 15% on all items. 15% was chosen arbitrarily as representing the maximum amount by which costs were likely to exceed the basic estimates. The use of 15% was agreed with USAID. As a low cost case we used the base capital costs without allowance for contingencies; this was chosen as the lowest cost envisaged by the engineers.

206. In addition, in those projections in which we supposed that sewerage costs were to be at least partly met out of water revenues, we considered the effect of using sewerage lagoons rather than a trickling fitter plant. Hazen and Sawyer estimate that the saving from lagoons would be $3,480,100 (including contingencies) which is 15.1% of base case sewerage costs and 7.8% of total base case capital costs.

207. We understand that the NWSA has rejected a number of other design changes suggested by Hazen and Sawyer as ways of reducing capital costs including:-

(a) eliminating the Medina booster pump station;

(b) reducing the depth of cover on sewers;

(c) manufacturing reinforced concrete pipe locally.

As these changes have definitely been rejected we were instructed by AID/Washington not to undertake any sensitivity analysis of their effect on tariff levels.

Al Haima Compensation

208. Hazen and Sawyer's project costs do not include compensation for Al Haima landowners for the loss of irrigation water. The amount of this compensation is still highly uncertain. Hazen and Sawyer have estimated that in 1990 the loss of water will reduce the value of agricultural production at Al Haima by $1.3 million per annum. They have also said that they have agreed with the NWSA that a discount rate of 7% should be used to calculate the present value of the lost production. This approach implies that compensation should be $18.6 million (the present value of production lost in perpetuity is equal to the annual amount divided by the rate of interest, i.e. 1.3/0.07 = 18.6).

209. However, the capital cost of the scheme to return reclaimed waste water to Al Haima, which was rejected as too expensive, was only $9.6 million including escalation and contingency allowances. It therefore seems likely that the compensation eventually paid to the Al Haima landowners will fall short of the amount indicated by the Hazen and Sawyer formula. We have therefore assumed that compensation will cost $5 million, that is about half the costs of the scheme to return waste water.

210. It should be noted that it might be possible to offset the costs of compensation by selling reclaimed water for irrigation to farmers closer to Taiz. This reclaimed water might also have industrial uses. The scope for such sales and the costs of reclaiming water for local use have not yet been fully established and so we were unable to examine them in our tariff analysis. A waste water reclamation scheme might however be a useful adjunct to the project as at present conceived.

Inflation

211. For the purposes of the tariff analysis we expressed all costs in terms of constant March 1977 prices. Inflation is important however in as much as it affects the nominal financing requirements of the project.

212. We consider that Hazen and Sawyer have underestimated the likely nominal cost of the project and hence the amount of finance required. In this subsection we:-

(a) explain Hazen and Sawyer's calculation of the likely increase in costs;

(b) comment on likely inflation rates;

(c) recalculate the escalation allowances using our preferred assumptions.

Hazen and Sawyer's
Escalation Allowances

213. The basic costs shown in paragraph 204 above are also in March 1977 prices. Hazen and Sawyer allowed only for escalation in the basic water supply and sewerage system costs excluding contingencies, mobilisation, supervision, vehicles and land and rights of way. The allowance for escalation in local costs is 66% of the basic costs. This figure was calculated by assuming:-

(a) an annual inflation rate of 25%;

(b) that local costs will be spread evenly over the construction period so that the average cost increase can be fairly represented by the increase to the midpoint of the construction period - June 1979.

The allowance for foreign cost escalation is 10%. This assumes an inflation rate of 10% per annum and that firm orders will be placed within one year.

Inflation Rates

214. We do not agree with the inflation rate assumptions made by Hazen and Sawyer. Firstly, we consider that a rate of 10% per annum is too high for foreign costs and suggest an allowance of 8% per annum. Secondly, we consider that the increase in local costs, expressed in Rials, is likely to exceed 25% per annum. We discussed local inflation rates with the Central Bank of the Yemen and were told that inflation in 1975/76 had been about 50% and that they envisaged inflation continuing at between 40% to 50% per annum for the next five years.

215. The problem is, however, complicated by the need to make an assumption about future exchange rates. Hazen and Sawyer effectively assumed that the dollar/rial exchange rate will

be held constant (as it has been since 1973) - if the exchange rate were to depreciate to reflect the difference between local and foreign inflation rates then local costs expressed in dollars would rise only at the foreign inflation rate. The Yemen at present has a very strong foreign payments position - its international reserves rose from $233 million at the beginning of 1975 to $741 million at the beginning of 1977. It therefore seems reasonable to suppose that the exchange rate could be held constant over the next three to four years even with local inflation rates of 40% to 50%.

Recalculation of Escalation Allowances

216. We recalculated the escalation allowances so as to:-

(a) include escalation on the costs excluded by Hazen and Sawyer (see paragraphs 201 and 202 above);

(b) reflect the actual phasing of construction costs rather than the assumption that all local costs are spread evenly over the whole period and all foreign costs are incurred within one year;

(c) show the effects of our inflation rate assumptions.

217. We based our estimates of project phasings on Plate VI of Hazen and Sawyer's March report: this shows the expected dates of construction of each major component of the project. Unfortunately we did not have the most recent estimate of total cost broken down by major component so that we had to use component costs as estimated in April adjusted pro rata to reflect changes in the total cost. In addition we were advised by Hazen and Sawyer that all foreign and 29% of local costs represented materials and we assumed that half of these were short and half long delivery items.

218. We therefore estimate that, including all costs except Al Haima compensation and assuming local inflation to be 40% per annum and foreign 8% per annum, the total nominal cost of the project will be $71,038,100 compared to $44,883,300 in constant prices - an increase of 58.3%. The total cost comprises:-

(a) $46,561,700 local costs compared to $23,205,700 - an increase of 100.6%;

(b) $24,536,400 foreign costs compared to $21,677,600 - an increase of 13.2%.

219. It is interesting to note that using our cost and phasing estimates but Hazen and Sawyer's inflation rates implies:-

(a) total project costs of $62,359,900 - an increase of 38.9%;

(b) local costs of $37,141,500 - an increase of 60.1%;

(c) foreign costs of $25,218,400 - an increase of 16.3%.

Debt Servicing

220. The NWSA has already accepted a loan of $1.35 million from USAID to finance the project design and well drilling. We have allowed for the debt servicing obligations arising out of this loan in all our financial projections.

221. It was agreed with USAID that we should review the implications of providing the additional finance required for the project in the following three ways:-

(a) entirely as equity;

(b) in the ratio 65 debt : 35 equity;

(c) $10 million as equity and the rest as debt.

We used the 65:35 debt equity ratio as our base case since AID viewed this as the most likely financial structure.

222. The precise debt:equity ratio yielded by case (c) is a function of the level of costs and in particular of the rate of inflation - the amount of equity is fixed in money terms so that the proportion of debt will be higher the greater is the rate of inflation. As we were working in constant prices we had to modify this assumption. We therefore calculated that with inflation at the rates suggested by Hazen and Sawyer a fixed equity investment of $10 million would yield a debt:equity ratio of 85:15 and used this in our calculations.

223. At USAID's suggestion we assumed that additional loans would be provided on the following terms:-

(a) five year grace period;
(b) repayment over 15 years in equal annual instalments;
(c) interest at 5% per annum, accrued during the grace period;
(d) all debt servicing payments due in foreign currency.

224. We estimated the increase over time of the Authority's debts by taking the construction cost phasing derived as explained in paragraph 209 and making the additional assumptions that:-

(a) materials will be paid for on delivery;
(b) contractors will be paid one quarter in arrears less 10% of their charges which will be withheld until completion of the project.

225. Finally, we allowed for a fall in the real cost of debt servicing at a rate of 8% per annum. This assumes not only that loans are fixed in foreign currency but also that following the construction period the exchange rate will depreciate to reflect any difference between foreign and local inflation rates.

Depreciation

226. Hazen and Sawyer suggested the following asset service lives:-

(a) 50 years: structures and pipelines;

(b) 25 years: process equipment, steel tankage, standby generators, electrical equipment and wiring (except instrumentation), valves (except frequently operated or on sludge lines), water pumps, wells;

(c) 12.5 years: well, sewerage and electric pumps, instrumentation, frequently operated valves, chlorinators, generators (except standby);

(d) 6.25 years: vehicles;

(e) indefinite: land and rights of way.

All these lives seem reasonable and were used, with one exception, to calculate the depreciation provisions included in our cost projections.

227. The exception is that we consider that depreciation should not be charged on pipelines. The pipe network as such will never require replacement in one operation but instead, each year, sections of pipelines will be repaired or replaced as part of the normal maintenance programme. Thus, so long as the operating cost projections allow for expenditure on maintenance sufficient to maintain the pipe network in a good-as-new condition - and Hazen and Sawyer confirmed that this is so - then it would be double-counting also to charge depreciation.

228. We allowed for depreciation on those existing assets that will be kept after completion of the project. These were valued by Hazen and Sawyer at their current as-new replacement cost. We based the annual depreciation charges on the original lives of the assets not their remaining lives - for example, the charge in respect of an asset with an original life of 50 years and a remaining life of ten years was taken to be 1/50 of the current replacement cost valuation. This implies that the total accumulated depreciation charge will be less than the replacement cost since:-

(a) past depreciation provisions were based on historic costs;

(b) the useful lives of some assets have been reduced because of the different needs of the system after completion of the project.

However we considered that it would be unduly burdensome to attempt to recoup the past under provision of depreciation in the early years of the project's life and that, in any case, it was unlikely that the NWSA would attempt to do so.

229. Our treatment of the existing assets differs from that of the new project assets since we included depreciation on the existing sewerage pipelines. This was done since we understand that these pipelines, which do not meet the standards laid down for the new pipelines, will eventually be replaced and not just repaired on a piecemeal basis.

230. We were not given a division of the existing 50-year water system assets into pipelines and others. In order, therefore, to be able to exclude depreciation on the water pipelines we assumed that the proportion of existing assets represented by pipelines was the same as in the case of the new project assets.

231. Similarly we were not given a division of the savings from the use of lagoons into assets of different lives. We therefore assumed that these savings could be spread over the different classes of asset (except pipelines, land and vehicles) in proportion to their share in the total sewerage cost.

232. We have included depreciation on meters (but not on the other elements of a house connection which we consider should be treated as any other pipeline). Although all meters are at present owned by the customers we recommend that in future the meters should remain the property of the Authority which should take on the responsibility for repairing and replacing meters without further charge to the customer. The advantages of this approach are that:-

(a) the present system of making repair and replacement the customers' responsibility has not worked - over 2,000 meters currently require extensive repair or replacement;

(b) it is inequitable to charge each customer the cost of replacing his own meter - a customer could be unlucky and be allocated a meter which failed soon after installation;

(c) the NWSA has adopted this convention for the other towns.

233. Although the meter is to remain the property of the Authority we still recommend that the Authority should aim to recoup the full cost of house connections, including meters, from the customers. We have taken the life of a meter to be the same as a frequently operated valve - 12.5 years.

OPERATING AND MAINTENANCE COSTS

234. Hazen and Sawyer provided the following formula to be used to calculate operating costs (all costs are expressed in 1977 Rials per year):-

I: Water System Costs

(a) Foreign materials:	874,000 -	fixed;
	20 -	per water service;
	8.05 -	per cubic metre of water produced on average each day (i.e. if the average daily production was 100 cubic metres the annual charge would be YR805).
(b) Local materials:	260,000 -	fixed;
	14.8 -	per additional water service provided after 1980; Hazen and Sawyer estimate that there will be 13,076 water services by 1980.
(c) Personnel:	2,298,000 -	fixed;
	67.5 -	per additional water service.
(d) Power:	342,000 -	fixed;
	45 -	per cubic metre produced on average each day; this is the cost of the Al Haima well field;
	202,000 -	in 1990 only; this is the additional cost of operating the Wadi Salah and Wadi Seena wells;
	0.0893 -	times the average daily production raised to the power 1.47; this is the cost of booster pumping.

II: Sewerage System Costs

(a) Foreign materials:	152,000 -	fixed.
(b) Local materials:	173,000 -	fixed.
(c) Personnel:	919,000 -	fixed;

(d) Power: 137,000 - fixed;

17 - per cubic metre of sewerage flowing through system on average each day; it is assumed that 80% of the water used by households with a sewerage connection enters the sewers.

235. Hazen and Sawyer also estimated that if lagoons were used instead of a treatment plant then:-

(a) fixed operating costs would fall by YR416,400 a year;

(b) there would be no variable power costs;

(c) there would be an additional local material cost of YR3,400 a year for each additional year following the completion of construction.

236. We also included YR235,200 a year as the Taiz branch's share of NWSA head office costs. This represents 30% of the costs incurred in the year to 30th June 1976 plus an allowance of 40% to cover inflation since then (40% of the costs were notionally allocated to Sana'a and 30% to Hodeida).

237. Because of the large elements of fixed costs the average cost per cubic metre of water produced tends to fall significantly with increases in volume. We calculated using our base case connection and consumption assumptions that the average cost of water produced (excluding all sewerage costs) would fall from YR1.284 in 1981 to YR0.871 in 1990.

238. It is interesting to note that the costs indicated by the formula are substantially less than the costs currently incurred by the KMWS - in the first five months of 1976

the average cost per cubic metre produced, allowing for 30% wastage, was YR1.617; assuming inflation to be 40% per annum this implies a cost in 1977 prices of YR2.264. As the KMWS has been restricting its operating and maintenance costs below desirable levels - at times the water has not been chlorinated and the plant has not been properly maintained - the lower operating costs forecast for the new system are at first surprising. The reason is again the high level of fixed costs and the greater volume of throughput. (It is interesting to note that the Hazen and Sawyer formula applied to output in 1976 implies a cost of YR1.96 per cubic metre produced.)

239. The only detailed information which we received on operating and maintenance costs was Appendix I of Hazen and Sawyer's March report. This sets out recommended salary and staffing levels for the KMWS. We reviewed these recommendations in the light of the actual salary and staffing levels of the KMWS in 1976 and of the salaries paid by other employers in the Taiz area in 1976. In our opinion:-

(a) a number of the recommended salary levels are too high;

(b) the staffing levels suggested for some functions are too low; for example, the recommended numbers of meter readers and billing clerks are less than the numbers actually employed in 1976.

240. We recalculated personnel costs using our estimates of suitable staffing and salary levels and found that the cost of additional staff was almost exactly offset by the savings from lower salary levels so that overall the net effect of our revisions would be to increase salary costs by just over 1%.

241. In the absence of supporting information we were unable to comment on the calculation of the other components of operating and maintenance costs.

242. In our base case calculations we applied Hazen and Sawyer's formula to our demand estimates. In our sensitivity tests we considered the effects of operating costs 15% greater or lesser than those predicted by the formula.

CONNECTION COSTS

243. Connection costs can be divided into two parts:-

(a) the costs of connecting a building to a secondary distribution/collection pipe;

(b) a share in the costs of installing the secondary distribution/collection pipes.

244. At present the municipality requires those wishing to connect to its sewerage system to cover both types of cost - a secondary collection pipe is not installed in a street until those living there agree to bear the cost. On the other hand the KMWS requires new customers to pay only the costs of connecting their property to the secondary distribution pipe.

245. The advantage of charging customers the costs of secondary distribution/collection pipes is that it reduces financing requirements and debt servicing costs. There are, however, serious disadvantages:-

(a) the capital costs of the secondary distribution and collection systems are so high as to be likely seriously to discourage connections - Hazen and Sawyer estimate that the costs per service will be YR3,619 for secondary collectors and YR1,141 for secondary distributors;

(b) the installation of the secondary pipe networks would be hindered if it were necessary to first arrange for the costs to be met.

246. We have included the costs of the initial work on the secondary pipe networks (including work to be undertaken by the KMWS) in the total project costs.

247. The KMWS will, however, have to continue to extend the secondary systems in the years following the completion of the project. Hazen and Sawyer have estimated that the annual costs, in March 1977 prices, of this work will be:-

(a) distribution system: YR1,458,000 in 1980 rising to YR2,206,000 in 1990;

(b) collection system: YR2,532,000 in 1980 rising to YR4,307,000 in 1990.

In our base case projections we have assumed that these costs will have to be met out of recurrent revenues, though as a sensitivity test we have considered the implications of financing this work with loans on the same terms as the initial project loans.

248. Below we have set out the costs of a house water and sewerage connection (excluding secondary pipe costs) as estimated by Hazen and Sawyer. No allowance is made for escalation or contingencies. We have no estimates of the costs of connecting large non-domestic consumers:-

Costs per Connection: YR		
A: Water connection:	materials	720
	labour	117
		837
B: Sewerage connection:	materials	506
	labour	150
		656

249. The materials element of the water connection costs includes YR315 ($70) for a water meter. This compares with a price of $16.75 FOB which we were quoted by a company supplying meters to the NWSA's Sana'a branch. The company also estimated that insurance and freight charges would add a further 7% to the cost making the total cost per metre $18 or YR81; this would reduce the cost of a water connection to YR603.

250. We recommend that the Authority should allow customers the option of paying connection costs by instalments. This will add to the Authority's working capital requirements and hence interest costs. However, as this option is intended as a concession to the poorer sections of the community we consider that the Authority should not aim to fully recoup all the additional interest costs; given that the Yemen Bank for Reconstruction and Development charges about 20% per annum, a rate of about 10% per annum seems appropriate.

251. If customers were to be allowed to pay over two years then this implies (in 1977 Rials) monthly instalments of YR28 for a water connection (assuming a meter costs YR81) and YR30 for a sewerage connection.

252. These figures will have to be revised to allow for inflation.

COST SENSITIVITIES

253. The various assumptions underlying the cost cases considered have all been mentioned earlier in this section. In the table below we have set out the total costs of the ten year period 1981 to 1990 projected for each case. The cases can be divided into two groups - those which include only costs related to the water system and those which also include some or all of the sewerage system costs:-

Total Costs 1981 to 1990

	YR Millions
A: Water System Costs	
Base case	157.4
High debt proportion	168.7
All equity	121.8
High capital cost	164.4
Low capital cost	154.3
High operating cost	169.0
Low operating cost	145.7
Extensions to secondary distribution network debt financed	140.8
High cost combination	189.8
Low cost combination	92.1
B: Sewerage System Costs	
All base case sewerage costs	258.0
Half base case sewerage costs	207.7

254. Except for the high and low cost combinations, only one element of cost is different from the base case costs in each case; for example, the costs in the high operating cost case are taken to be the same as in the base case except for operating costs which are assumed to be 15% higher.

255. The first group of cases include only costs related to the water system and exclude all sewerage system costs:-

(a) base case - total costs YR157.4 million:-

(i) capital costs as estimated by Hazen and Sawyer but including all relevant costs (see paragraph 196) and a 10% contingency allowance;

(ii) 65:35 debt equity ratio;

(iii) operating costs calculated according to the Hazen and Sawyer formula and assuming

base demand case projections are realised (i.e. they do not allow for changes in amount consumed because of price or for changes in number of connections);

(iv) all extensions to the secondary distribution system (excluding house connections) to be financed out of water revenues;

(b) high debt - total costs YR168.7 million - as base case except debt equity ratio taken as 85:15;

(c) all equity - total costs YR121.8 million - as base case but all debt service costs excluded;

(d) high capital - total costs YR164.4 million - as base case but all capital costs increased by 15%;

(e) low capital - total costs YR154.3 million - as base case except that 10% contingency allowance excluded;

(f) high operating - total costs YR169.0 million - as base case but 15% added to all operating costs (this cost case was not in fact run on the computer model as the total cost is very close to that in the high debt case);

(g) low operating - total costs YR145.7 million - as base case except operating costs reduced by 15%;

(h) extensions debt financed - total costs YR140.8 million - as base case except that extensions to secondary distribution assumed to be debt financed on same terms as initial project;

(i) high cost combination - total costs YR189.3 million:-

(i) debt equity ratio as in case (b);

(ii) capital costs as in case (d);

(iii) operating costs as in case (f);

(j) low cost combination - total costs YR92.1 million:-

(i) all debt servicing excluded;

(ii) capital costs as in case (e);

(iii) operating costs as in case (g);

(iv) extensions debt financed.

256. We also considered a number of cases including some or all of the sewerage system costs; these are:-

(a) All sewerage - total costs YR258.0 million - as base case but including all costs associated with the sewerage system. Sewerage costs were calculated using assumptions parallel to those adopted in base case.

(b) Half sewerage - total costs YR207.7 million - as case (h) but only half sewerage costs included.

(c) lagoons - total costs YR242.6 million - as case (k) but assuming that sewerage lagoons were used instead of a treatment plant.

257. In the various demand sensitivity tests described in Section IV above, we used the base case costs except that variable operating costs were recalculated using the Hazen and Sawyer formula. Similarly, variable operating costs were recalculated in the two supply sensitivity tests to allow for the effects of supply constraints on demand.

SECTION VI - TARIFF STUDY

258. This section describes:-

(a) the base case tariff analysis using the central demand and cost forecasts described in Sections IV and V above; and

(b) the results of sensitivity analyses showing the variation of base case tariffs with changes in assumptions on costs, demand and connection rates.

We consider water and sewerage tariffs separately and then together.

259. We indicate in Section VII the other factors which we believe the Authority should take into account in determining its tariff policy, and we continue this discussion in Section VIII in relation to the recommended tariff policy and tariff levels.

THE WATER TARIFF ANALYSIS

260. We discuss in turn:-

(a) the analytical method adopted;

(b) the results of the base case analysis;

(c) cost sensitivities;

(d) demand sensitivities;

(e) connection sensitivities.

Analytical Method

261. Our object was to calculate the price of water and the connection policy which the Authority should adopt, given considerable uncertainty about the future growth in demand for water and the costs of supplying it. The constraints imposed by our terms of reference are that the Authority should recover all its costs over a ten year period (1981 to

1990), that at least a minimum proportion of all dwellings and business establishments should be connected to the water and sewerage systems, and that there should be an adequate volume of water available to each connection each year. (The computer model which we developed to perform these calculations is discussed fully in Appendix 2 to this report.)

262. We have performed these calculations for a number of combinations of our demand and cost projections. By deriving several sets of results we are able to determine the sensitivity of policies based on our central projections (the "base case" discussed below) and so modify our recommendations to improve their robustness.

Applicability of Marginal Costs

263. For each case tested by the tariff model we analysed two price structures:-

(a) a fixed fee to cover fixed costs and a per unit price to cover marginal costs (a two-part tariff);

(b) a per unit price which recovers both fixed and variable costs (average cost pricing).

264. We were specifically asked to consider the relevance of the first of these options by our terms of reference. The two-part tariff is normally used so as not to discourage marginal consumption in an industry whose costs are predominantly fixed.

265. We estimate that the marginal costs of providing water in Taiz (that is the variable costs of production - power, chemicals, etc.) are only 0.2 Rials per cu.m. However, a tariff based solely on marginal costs would:-

(a) encourage consumption to increase to a level far in excess of reasonable needs;
(b) require a very high fixed charge to cover system overheads.

266. It is difficult to forecast demand in this situation, but such a policy would deter users with only modest demands from connecting to the system, and would require rationing and a limit on the total number of connections early in the life of the new system.

267. We concluded that, to get the benefits of maximising the number of connections and controlling wasteful consumption it would be better to charge a low fixed fee and a per unit price which was closer to the average cost of water.

268. We have therefore compared the average cost price structure with a two-part tariff based on continuing the Authority's present unit price (2 Rials) and recovering the increase in total costs through the fixed fee.

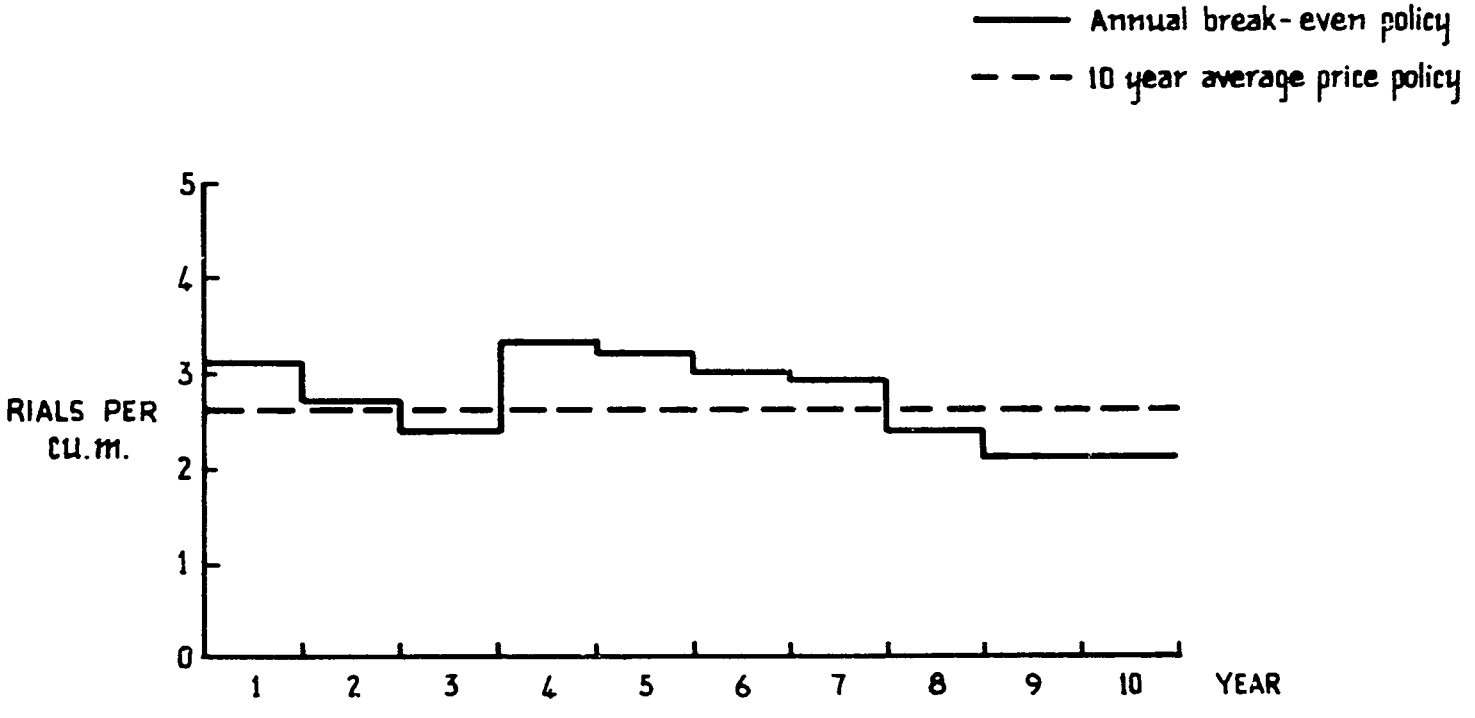
Constant Price Policy

269. In each case we have calculated the constant unit price of water (in 1977 prices) which recovers costs over the ten year period. In our view this is preferable to the significant fluctuations in price that would occur if prices were set so that the Authority were to break even each year. Diagram 1 shows the difference in average cost prices during the forecast period under these two policies.

270. A constant tariff policy has the advantage of spreading the heavy loan repayment costs in the middle of the period over a larger number of customers and accounting periods, and will assist the Authority in maximising the number of new connections made in the early years. It will also encourage

Diagram 1

COMPARISON OF 10 YEAR AVERAGE & ANNUAL BREAK EVEN TARIFFS



consumption in the middle of the period when spare capacity is available, and, compared with a fluctuating tariff, defer the date at which rationing is required.

Base Case Results

271. The base case combines all the central forecasts of the variables involved in the tariff calculations. It is not correct to say that it represents the "most likely" combination of these variables but it provides a datum against which to evaluate the effect of changes in the input assumptions.

272. The detailed assumptions were discussed in Sections IV and V; in summary the base case assumes:-

(a) growth of Taiz at 9% per annum (1981 to 1990);

(b) growth in personal consumption of 30% (1981 to 1990), and in non-domestic consumption at an equivalent rate;

(c) growth in proportion of connected households from 70% in 1981 to 90% in 1990, and in proportion of connected businesses from 45% to 72%;

(d) Hazen and Sawyer's estimated capital and operating costs for the water system (corrected as described above);

(e) AID's central funding assumption ($14.2 million debt; $7.7 million equity) and loan terms (5% interest with repayments in 15 equal instalments from 1985 onwards);

(f) Hazen and Sawyer's central well production estimate (11.5 million cu.m. per annum), less an estimated 20% water loss in the distribution network;

(g) limit of 3,800 new connections each year.

The results of the base case analysis are shown in Table 8 below.

273. The average cost price of 2.60 Rials per cu.m. (in 1977 prices) represents a 30% increase over the actual price of 2.00 Rials in 1976/77, although no change over the estimated 1976 costs of operation (see Table 1 above).

274. As a two-part tariff assuming a variable charge of 2 Rials/ cu.m., the fixed fee represents an increase of 6.60 Rials/ month compared with the existing fixed fee of 1 Rial.

275. Considering the improved quality, quantity and reliability of supply which are expected, and the fact that the present tariff is less than the unit cost of water, we consider these increases to be of an acceptable magnitude.

276. The table also indicates that there would be sufficient capacity in the system to connect almost all the households or businesses which the survey results suggest are likely to be interested in connection, provided that the proposed rate of connections could be maintained.

277. Domestic consumption would rise, although by the end of 1990 some general rationing (by supply constraints, by further price increases or by reducing the rate of new connections) would be necessary. Rationing at peak demand periods might need to be introduced a year or two earlier.

Table 8 - Base Case Results

	Average Cost Price	Two Part Tariff
1. Price per unit (Rials)	2.60	2.00
2. Monthly fixed fee (Rials)	-	7.60
3. Average Domestic Bill (Rials per Month)		
1981	31.20	32.90
1985	34.90	35.90
1990	40.60	40.40
4. Domestic Consumption (l/c/d)		
1981	69	72
1985	77	80
1990	89	93
5. % of Water Supply Used (Mean)		
1981	33	35
1985	62	65
1990	108(1)	108(1)
6. % of Households Connected at Year End		
1980	70	70
1985	90	90
1990	90	85
7. % of Business Connected at Year End		
1980	45	45
1985	72	72
1990	69	63

NOTE:

(1) Demand exceeds supply in 1990; unless supply can be increased from that date, some element of rationing (by limiting supply or connections or by raising prices to reduce demand) may need to be introduced;

(2) these results compare with a cost of 2 Rials/Cu.m. in 1976 for an average domestic consumption of 55 l/c/d; the average bill would have been 20 Rials/month.

(3) results for prices and monthly bills are rounded to the nearest 10 fils.

278. Although there is a significant difference in the water tariff between the average cost price and the two-part tariff, the average domestic bills would be very similar because of the fixed fee (see Diagram 2). While some larger households might consume slightly more water at the lower unit price, the majority would pay more for water than they would under an average cost price. For this reason we confine the discussion in the remainder of this chapter to the average cost price policy. Results for the two-part tariff policy are set out in Appendix 4.

Cost Sensitivity Tests

279. We have tested the sensitivity of the base case tariffs to single and multiple changes in the cost assumptions, representing uncertainty in the estimates of:-

- capital and operating costs;
- debt:equity ratio;
- volume of water supplied.

The full range of tests and the reasons for uncertainty are defined in Section V.

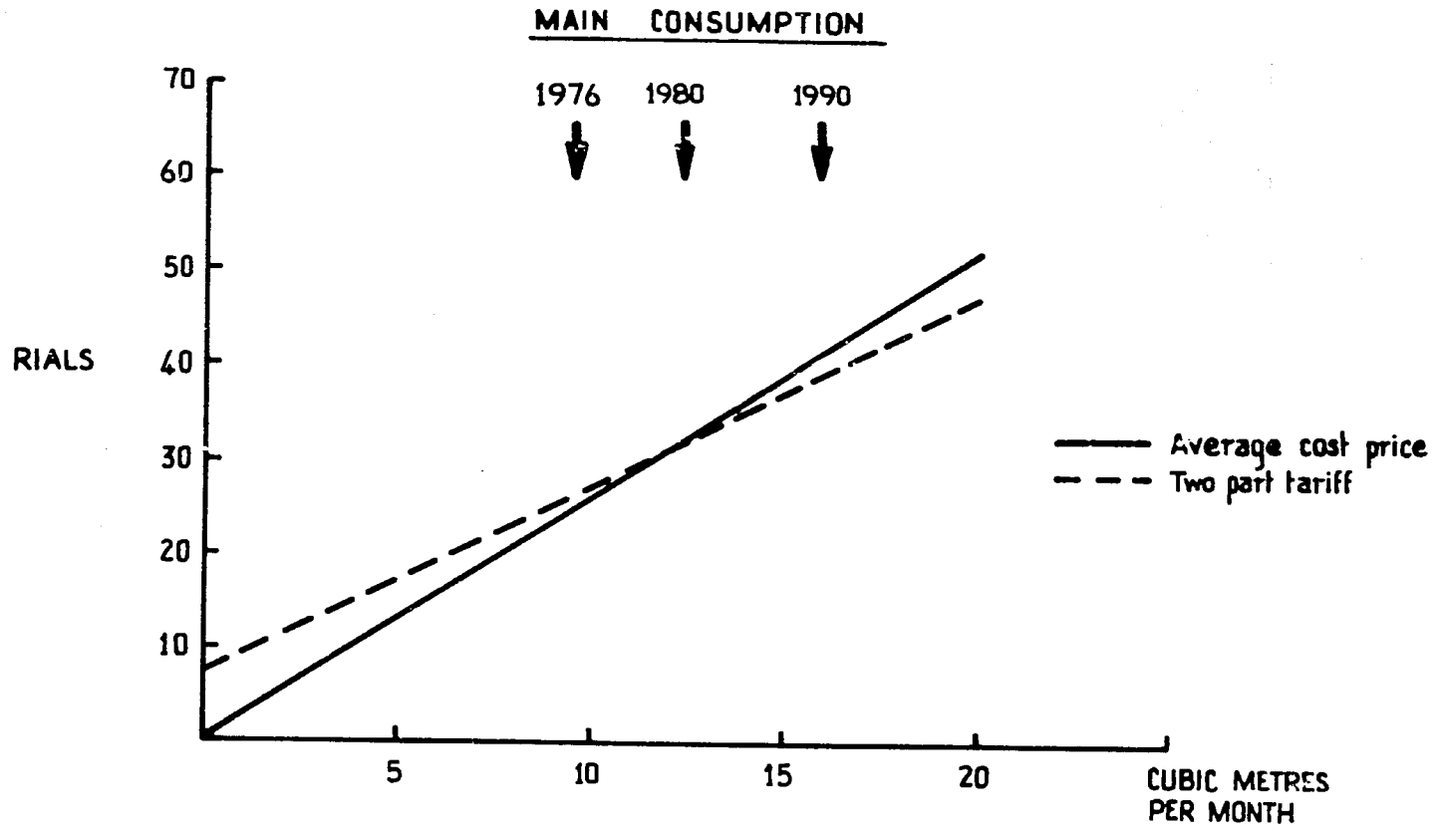
280. A great deal of this uncertainty arises from the fact that the system is not yet built. At some later date, when the capital costs and funding terms are known, it would be worthwhile for the Authority to repeat some of our analyses to determine more precisely the actual price they ought to charge. At the same time more would be known about the system operating costs and supply.

281. Nevertheless the analyses that are reported here identify the key factors that will influence price levels, and may suggest priorities for the Authority and the Agency to consider when finalising the system design and loan terms.

Diagram 2

AVERAGE DOMESTIC MONTHLY BILL UNDER ALTERNATIVE CHARGING POLICIES

BASE CASE



282. Table 9 summarises the effect of changes in cost variables; the rate of connections that can be achieved is not affected, and this information is not repeated in the table. As in the base case, all these tests suggest (unless stated otherwise) that rationing might need to be introduced from 1990 onwards.

Capital and Operating Costs

283. Within the limits of the variations which we tested, changes in capital and operating costs would have only a small effect on tariffs. The higher capital cost assumption resulted in an increase of only 0.10 Rials per cu.m. over the base case, whereas the higher operating cost assumption resulted in an increase of 0.20 Rials. The lower cost assumptions produced similar changes in the opposite direction.

Debt/Equity Ratio

284. The largest change in base case tariffs was caused by changing the funding mix (debt:equity ratio) assumed in the base case. A higher proportion of debt (85%) resulted in an average cost tariff of 2.80 Rials per cu.m.; the all equity case resulted in a tariff of 1.90 Rials per cu.m.

Volume of Water Supplied

285. Variations in the volume of water supplied would have a significant effect on the level of water sales, and on the numbers of connections, which could be achieved. A 20% increase in supply would defer the need for additional system capacity until early 1992 and would not affect prices; a 20% reduction in supply would mean introducing general rationing in 1988, as well as increasing prices to 2.80 Rials to compensate for lost water sales in the later years of the period.

TABLE 9 - SENSITIVITY TO CHANGES IN COST ASSUMPTIONS

		CAPITAL COSTS		LOAN TERMS		WATER SUPPLY		OPERATING COSTS	
		HIGH	LOW	HIGH DEBT	ALL EQUITY	HIGH	LOW	HIGH	LOW
1. Price per unit	(Rials)	2.70	2.50	2.80	1.90	2.60	2.80(2)	2.80	2.40
2. Monthly fixed fee	(Rials)	-	-	-	-	-	-	-	-
3. Average domestic bill	(Rials/month)								
1981		32.40	30.70	33.30	24.10		33.30	33.30	29.10
1985		37.30	34.40	37.40	27.00	SAME AS BASE CASE(1)	37.40	37.40	32.40
1990		42.30	40.00	43.60	31.30		41.70(2)	43.60	37.60
4. Domestic consumption	(l/c/d)								
1981		68	69	67	72		67	67	70
1985		75	78	76	81		76	76	78
1990		88	89	87	94		80(2)	87	91

NOTES:

(1) The only difference from the base case is that a lower percentage of capacity is demanded: 28% in 1981, 52% in 1985 and 100% in 1990.

(2) Conversely, in this case a higher proportion is demanded: 42% in 1981, 78% in 1985 and 135% in 1990; the Authority would have to introduce general rationing from 1988 onwards; the estimated prices for this case are therefore only approximate.

Combined Cost Variations

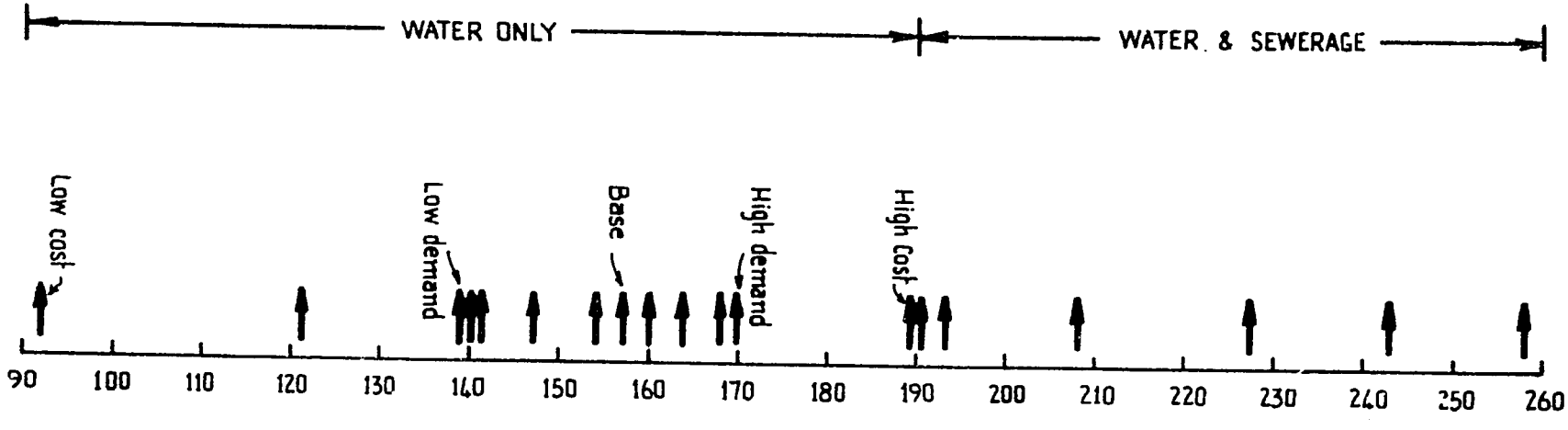
286. Diagram 3 shows the wide range of possible cases which arise when the base case cost assumptions are varied in combination. It is not possible to identify the most likely cost situation which will face the Authority, so we have evaluated the effect of the highest and lowest cost variations that could arise with the base case input assumptions. Although the likelihood of these variations occurring is slight, the cases identify the probable limits to the uncertainty surrounding our tariff calculations.

287. In the "high cost" case, we have considered the possible effect on tariff levels of a combination of high capital and operating costs and the high debt funding option. It can be seen from Table 10 that the unit price might increase to 3.30 Rials, a 25% increase over the base case.

288. In the "low cost" case, we have combined the low capital and operating costs and the all equity funding option, and have assumed that future extensions to the system would be financed out of loans rather than from water sales revenue. In that case, the unit price might fall to 1.20 Rials, less than half the price in the base case (this would require severe rationing to be introduced generally from 1988).

Diagram 3

RANGE OF COST CASES CONSIDERED



Total yield required 1981-90
(millions YAR Rials)

Table 10 - Sensitivity to Changes in Combinations of Cost Assumptions

		High Cost Combination	Low Cost Combination
1. Price per unit	(Rials)	3.30	1.20(1)
2. Monthly fixed fee	(Rials)	-	-
3. Average domestic bill	(Rials/month)		
1981		37.80	18.70
1985		42.80	21.00
1990		49.80	24.30
4. Domestic consumption	(l/c/d)		
1981		65	93
1985		74	104
1990		85	120(1)

Notes: (1) Prices as low as this would increase demand in 1990 to 124% of capacity; the Authority would have to introduce rationing from 1988.

Demand Sensitivity Tests

289. We have also tested the sensitivity of the base case tariffs to changes in the demand assumptions, representing uncertainty in our forecasts of the future growth rate of Taiz and of the likely growth in consumption from an unrestricted water supply. The cases which are discussed below represent, in our view, the bounds within which tariffs might vary as the combined result of these uncertainties. (The tests are defined in Section IV.)

290. Although much of the uncertainty which surrounds the cost estimates will be removed when tenders are available, it is likely to be very difficult to narrow the range of demand estimates in the near future. There are however two factors which may assist the Authority in any future revision of our analysis.

291. First, the current work on the Master Plan for Taiz is likely to suggest an "ideal" size for the city which will define the target population to be served rather better than we have been able to do (although in practice, without development controls in Taiz and with limited development opportunities elsewhere, it is doubtful whether the ideal size could be enforced).

292. Secondly, as water becomes more freely available from 1980 it will be possible very quickly to establish whether responses from our socio-economic surveys on anticipated consumption from the new supply were of the right magnitude or whether there has been a major "learning" effect which has put demand on to a different growth path.

Low Growth Sensitivities

293. The results of our assessment are shown in Table 11. If the growth rate of Taiz were lower than that assumed in the base case prices would have to rise to generate sufficient

Table 11 - Sensitivity to Changes in Combinations of Demand Assumptions

		Low Growth Low Demand	Low Growth High Demand	High Growth Low Demand
1. Price per unit	(Rials)	3.60	3.10	2.20
2. Monthly fixed fee	(Rials)	-	-	-
3. Average domestic bill	(Rials/ month)			
1981		40.40	35.90	27.60
1985		43.40	41.40	29.80
1990		47.50	50.00	32.80
4. Domestic consumption	(l/c/d)			
1981		63	66	71
1985		68	76	76
1990		74	92	84
5. % of water supply used (mean)				
1981		26	28	37
1985		41	47	67
1990		61	77	100
6. % of households connected at year end				
1980		70	70	70
1985		90	90	80
1990		90	90	59 (1)
7. % of businesses connected at year end				
1980		45	45	45
1985		66	66	45
1990		72	72	35 (1)
8. Total new connections per annum		2,100	2,100	3,640

Notes: (1) Because of the faster growth in the number of households and businesses this case would result in rationing at an earlier date than the base case and connection of a lower proportion of potential users; whether the target connection levels can be reached will depend on the feasibility of further expansion of the connection programme.

revenues to meet the financial objective. In the low growth/low demand case the break-even price would be 3.60 Rials/cu.m. The size of the price increase would be reduced if consumers used more water, although it is unlikely that demand per connection would ever be significantly greater than in the base case. In the low growth/high demand case, the break-even price would be 3.10 Rials per cu.m.

High Growth Sensitivity

294. If on the other hand the growth of Taiz is faster than we have assumed in the base case then, in the high growth/low demand case, the break-even price would be 2.20 Rials per cu.m. High growth combined with high demand per connection would lead to a shortage of water in the mid-1980s and to severe rationing from early in the forecast period. In our view such an option did not merit detailed analysis.

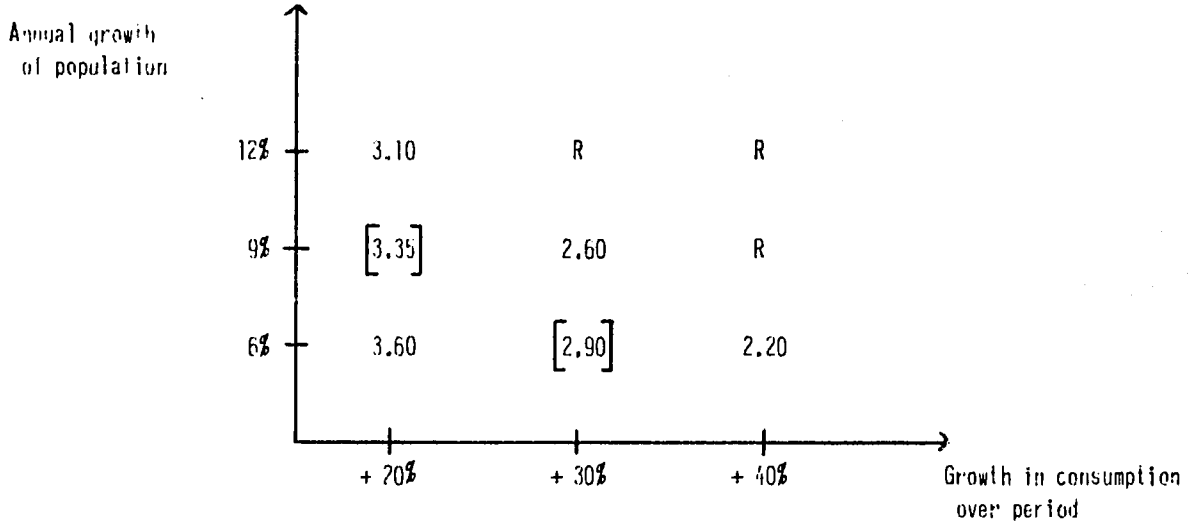
295. In the low growth demand cases, an annual connection rate of 2,100 would be sufficient to connect all those whom we estimate are likely to be interested in connection. In the higher growth case, however, the base case connection programme would not connect the minimum target proportion of households and businesses. A rate of about 4,600 connections would be necessary each year, and we have doubts as to the feasibility of achieving and maintaining such a rate.

Other Demand Sensitivity Tests

296. Diagram 4 indicates the relationship between the results of the base case and the demand sensitivities that we have tested, and interpolates the average cost tariff for other possible combinations of demand input assumptions. Within the limits of the socio-economic data discussed in Section IV we have assessed the implications of all likely demand outcomes.

DIAGRAM 4 - SENSITIVITY OF UNIT PRICE TO CHANGES IN DEMAND ASSUMPTIONS

(Rials)



R - shortage of supply would lead to rationing in the mid-1980s in these cases;

[ ] - interpolated results.

297. We have not, however, tested the sensitivity of base case tariffs to combinations of different cost and demand assumptions. Without a better understanding of the probabilities of some of these alternative outcomes such tests would only widen the range of uncertainty and could be misleading.

Sensitivity to Variations in Connections

298. We have tested the sensitivity of the base case tariff levels to two types of changes in the rate of connection - the effect of the Authority pursuing a lower connection programme, and the effect of fewer households and businesses wishing to connect.

Low Connection Programme

299. We compared three alternative connection programmes with the base case assumptions:-

(a) a rapid build-up of connections in the early years to maximise use of the system followed by a slower connection rate for the remainder of the period to connect the same number of households and businesses as in the base case (4,500 per annum to 1984 then 3,000 per annum);

(b) a low connection programme appropriate to the lower growth demand cases (2,200 per annum);

(c) an intermediate connection programme (3,000 per annum).

300. Table 12 shows that the results of the rapid build-up case are almost identical to the base case. Almost all of the households and businesses wishing to connect would be able to do so, and the unit price of water would be unchanged.

301. On the other hand, a connection rate of 3,000 would connect all the households which wished to connect, but would only connect the minimum proportion of businesses defined in the base case; as a result prices would increase to 2.70 Rials per unit. A connection rate of 2,200 would only connect the minimum proportions of households and businesses, so the unit price would increase to 3.30 Rials.

Low Willingness to Connect

302. The base case connection programme assumed that the same proportion of households and businesses will be willing to connect to the water system in the future as now. However, if the costs of connection increase this may not be the case. We have therefore assessed the effect on tariffs of a fall in the proportion of households willing to connect from 90% to 80% and a fall in the proportion of businesses from 72% to 64%.

303. Table 12 shows the result of this test also. To compensate for lost water sales, the average tariff would have to be 2.90 Rials per cu.m. A connection programme of 3,000 connections per annum would be sufficient to connect all the establishments wishing to connect.

Summary of Water Tariff Sensitivity Tests

304. With the base case assumptions, the Authority would break even with an average cost price of 2.60 Rials/cu.m. However, uncertainty in the cost assumptions could lead to variations in the break-even price between 1.20 Rials and 3.30 Rials; uncertainty in the demand assumptions could cause the price to vary between 2.20 Rials and 3.60 Rials, and variation in the connection rate could lead to a price variation between 2.60 Rials and 3.30 Rials.

Table 12 - Sensitivity to Variations in Rate of Connection or Proportion Willing to Connect

		Rapid Build-up	Inter-Mediate Rate	Low Rate	Fewer Willing
1. Price per unit	(Rials)	2.60	2.70	3.30	2.90
2. Monthly fixed fee	(Rials)	-	-	-	-
3. Average domestic bill	(Rials/ month)				
1981		31.30	32.80	37.50	34.20
1985		35.00	36.70	41.90	38.20
1990		40.60	42.60	48.70	44.40
4. Domestic consumption	(l/c/d)				
1981		69	68	65	67
1985		77	76	73	75
1990		89	88	85	87
5. % of households connected at year end					
1980		70	70	70	70
1985		90	89	77	80
1990		88	86	70	80
6. % of business connected at year end					
1980		45	45	45	45
1985		72	45	45	64
1990		55 (1)	45	45	64
7. Total new connections per annum		4,500 to 1984 then 3,000	3,000	2,200	3,000

Note: (1) The revised base results are identical to the base case (3,800 connections per annum) except for the proportion of businesses connected in 1990.

305. Table 13 summarises the results of the individual sensitivity tests. We cannot identify any of these as more likely than any other - they are all equally critical to the Authority's choice of tariff. For this reason we suggest the Authority should keep some check on demand variables as well as monitoring costs of it is to have adequate warning of the need for real price changes.

SEWERAGE TARIFF ANALYSIS

Introduction

306. The analysis we have undertaken of sewerage tariffs is much simpler for the following reasons:-

(a) costs are predominantly fixed (depreciation and debt servicing), so that charges can clearly be related to receipt of the service rather than use;

(b) there are fewer input assumptions which require sensitivity testing.

307. First we have calculated the fixed monthly charge necessary to cover the costs of the sewerage service; this should be paid by all establishments receiving sewerage service. We then describe the sensitivity of the base case result to changes in the assumptions.

308. Finally, because the monthly charge is so great, we have assessed the effect of financing part of the sewerage service from water sales revenues.

309. Just as we did for water, we have calculated a constant monthly service charge which ensures that the Authority covers the costs of the sewerage service over the period 1981 to 1990 as a whole, rather than year by year. Deficits occurring in the early part of the period when the number of connections is small would be paid off in later years as the number of connections increased.

Table 13 - Summary of Sensitivity Tests

Variations in base case assumptions causing a 0.10 Rial/cubic metre change in base case tariffs.

Capital costs	± $1m.
Equity funding	± $1m.
Operating costs	± 5% per annum
Taiz growth rate	± 1½% per annum
Growth in consumption	± 5% per annum
Connection programme	± 400 per annum
% of establishments wishing to connect in 1990	± 3½%.

Base Case Results

310. The assumptions of the base case are summarised below:-

(a) growth of Taiz at 9% per annum (1981 to 1990);

(b) growth in proportion of connected households from 70% in 1981 to 85% in 1990 and in the proportion of connected businesses from 65% to 75%;

(c) Hazen and Sawyer's estimated capital and operating costs for the sewerage systems;

(d) AID's central funding assumption ($15.0 million debt, $8.0 million equity) and loan terms;

(e) limit of 3,600 new connections each year.

311. We calculate that on these assumptions the average monthly service charge should be 26.50 Rials. This would be made up as follows:-

operating costs	0.55 Rials/month;
depreciation	8.50 Rials/month;
debt	8.50 Rials/month;
construction of secondary systems	8.95 Rials/month.

Sensitivity Tests

312. We have tested the sensitivity of this result to:-

(a) changes in the capital costs of the systems;

(b) alternative debt/equity ratios;

(c) alternative rates of growth of Taiz;

(d) changes in the connection target or rate.

Capital Costs and Debt/Equity Ratios

313. If capital costs were to be increased by 15% the depreciation and debt charges would each increase by 15%. The monthly charge would have to be 29.00 Rials. If capital costs were

to be reduced by $1.4 million, reflecting the lower cost of lagoons compared with the filtration plant, the monthly charge should be 25.50 Rials.

314. With 85% debt funding, the monthly sewerage charge should be 28.10 Rials. If the project were all equity financed the monthly charge should be 18.00 Rials.

Population Growth and Connection Rate

315. If the population growth rate was 6% or 12% instead of the 9% assumed in the base case, and if the same proportion of the population was connected, the average monthly cost per connection should be 37.50 Rials or 20.50 Rials respectively.

316. If the average connection rate was 10% higher or 10% lower than assumed in the base case the average monthly charge should be 25.10 Rials or 32.10 Rials respectively.

Summary of Sewerage Charge Sensitivity Tests

317. The average monthly charge on our base case assumptions would be 26.50 Rials. Changes in the input assumptions would cause this to vary between 18.00 Rials and 29.00 Rials for cost variables, and between 20.50 Rials and 37.50 Rials for demand variables.

318. However we were unable to establish from our survey data the relationship between the cost of the sewerage service and the number of people wishing to connect. This increases the uncertainty in determining break-even sewerage tariff levels.

Joint Water and Sewerage Tariffs

319. At present the majority of establishments pay nothing for sewerage service. Charges of the magnitude discussed above could be a deterrent to some households and businesses to connect.

320. We therefore considered the effect on water consumption, and on the water tariff, of funding differing proportions of the cost of the sewerage service from water sales revenues. The results of these tests are shown in Table 14.

321. If all of the costs of the sewerage service were to be recovered, the average price of water would rise to 5.10 Rials/cu.m. Modifications to the base case proposal, using lagoons rather than a treatment plant and funding extensions to the system out of further loans rather than from revenues, would require unit prices of 4.60 Rials and 4.20 Rials respectively to break even.

322. Each of these options would have such a large effect on the water price that we estimate households would consume little more water in 1981 with the new supply than they did in 1976 with a restricted water supply. We feel that such a result would be politically unacceptable and would fail to meet the objectives of the new systems, as discussed in more detail in Section VII.

323. As a simple intermediate test, we assessed the effect of recovering only half of the sewerage costs from water revenues, and the remainder from a monthly service charge. The average water price would then be 3.70 Rials per cu.m.; the monthly sewerage charge would be 13.30 Rials.

324. In summary, every increase in the unit price of water of 0.10 Rials would reduce the sewerage service charge in the base case by 1.20 Rials/month.

Table 14 - Base Case with Alternative Contributions to Sewerage Costs

	All Sewerage	Lagoons	Half Sewerage	Debt Financed
1. Price per unit (Rials)	5.10 (1)	4.60 (1)	3.70	4.20 (1)
2. Monthly fixed fee (Rials)	-	-	-	-
3. Average domestic bill				
1981	49.30	47.00	40.50	44.30
1985	55.50	52.50	45.50	49.30
1990	63.90	60.80	52.60	57.40
4. Domestic consumption				
1981	55	58	63	60
1985	62	65	70	67
1990	72	75	81	78

Note: (1) These results are only approximate, since they are outside the range of prices tested in the socio-economic surveys and our knowledge of demand responses is more limited.

SECTION VII - AIMS OF TARIFF POLICY

325. This section discusses the aims which tariff policy may be designed to meet. Together with the base case and sensitivity analyses these aims provide the basis for designing the recommended tariff structure to meet AID's project objectives, expressed in the terms of reference. The aims which are discussed are:-

(a) to improve health;
(b) to conserve resources;
(c) to increase general welfare;
(d) to redistribute income;
(e) to generate financial resources.

326. We discuss each of these in the following paragraphs in relation to water and sewerage services; as a consequence of the different aims of the two services we then set out in Section VIII the separate guidelines which the Authority should adopt in developing its tariff structure, and relate these to USAID's socio-economic and financial objectives (discussed in Section I).

HEALTH

327. Improving the quality of the water supply reduces the transmission of water-borne diseases. Other significant improvements in health may result from:-

(a) more frequent washing during the preparation of food;
(b) more frequent washing of clothes, floors and utensils leading to improved hygiene in the home, in cafes, schools and generally;
(c) increased use of water closets reducing bacteriological disease.

328. The health of the people of Taiz will improve if more of them have access to a satisfactory water supply and toilet facility. The Authority should therefore:-

(a) encourage the maximum number of households and businesses to connect to the new systems;

(b) ensure a reasonable level of consumption per water connection;

(c) provide free public facilities for those without their own water or sewerage connection.

329. A low unit price for the first units of water consumed would be the best way to encourage an increase in domestic consumption. On the other hand, marginal consumption by non-domestic consumers should not be deterred. The price charged for additional consumption should not therefore prevent these institutions and establishments from consuming as much water as they need.

330. Whatever levels are adopted a balance has to be struck between achieving a reasonable expansion of water consumption (by keeping water tariffs low) and a reasonable level of connection to the sewerage service (by keeping the sewerage charge low). This is essentially a political judgement for the Authority to make.

RESOURCE CONSERVATION

331. Water is likely to be relatively scarce in Taiz in the long run, and the water authority should therefore do as much as possible to conserve the available water resources and to contain consumption within the limits set by the available supply.

332. The implication of this objective, when considered in conjunction with the health objective discussed above, is that the use of the water supply for non-essential purposes should be strongly discouraged.

333. Domestic water consumption above a reasonable level for basic hygiene and cooking purposes should therefore be deterred. Although the demand for water is relatively price-inelastic, consumption above this level could be discouraged by a high charge per unit. (The higher rate however should not penalise large households and those with flush toilets.)

334. This objective also requires that non-essential commercial and industrial consumption should be discouraged. This could be done either by law or by charging excess demands at a penal rate. We recognise, however, that both of these policies would be difficult to administer. One solution might be to identify classes of demand which were almost entirely non-essential (gardening, street cleaning, car washing), and charge the whole of this consumption at a premium rate.

GENERAL WELFARE

335. Real income growth in Taiz (and so general welfare improvement) is likely to be associated with industrial development; if such development should be hindered by lack of water supplies, or if productivity should be reduced by sickness, there would be a general welfare loss. Pursuing such an objective would therefore require the water authority to provide water for all industrial consumers and to encourage high standards of public health; such a policy would generate employment and real income gains within the community.

336. However, there is no reason why the construction industry should be supplied from the new system, since it does not require water of the same quality that is necessary for domestic consumption. We suggest that the possibility should be explored of supplying construction sites by tanker with water from private wells, or from those existing Kennedy wells in Taiz which will not be incorporated into the improved supply system, or with treated water from the sewerage treatment plant.

INCOME REDISTRIBUTION

337. Governments in some countries have used public utilities' pricing policies as a means of redistributing income; for example, by charging different rates to different classes of consumer. Our terms of reference require us to consider the appropriateness of pursuing such a policy of cross-subsidy amongst consumers in Taiz.

Domestic Consumers

338. The household survey showed that the poor spend a larger proportion of their income on water and pay more per unit of water than the rich because at present they are less likely to be connected to the Kennedy system; also they are likely to consume less water per capita. Furthermore the poor are less likely to have access to adequate toilet facilities.

339. A simple tariff structure in which the cost of water and sewerage services were the same for all consumers, whether rich or poor, would be relatively onerous to the poor. The proportion of total income which is spent on water and sewerage services could be made more equal for all consumers by cross-subsidy of:-

(a) the monthly cost of service; or

(b) the connection cost.

These are discussed in turn.

340. We have come to the conclusion that any direct discrimination in the monthly cost of services is impracticable since:-

(a) there are no existing guides to household incomes:-

(i) the size or type of house or the number of persons in the household are not reliable indicators of the incomes of those living in it;

(ii) income tax returns cover only a small proportion of the population and do not anyway include non-cash income, such as free food or other items from villages or work place;

(b) it would be necessary to generate and keep records of customer incomes over time; such a system would be extremely difficult to maintain accurately, or to audit.

341. Indirect concessions could be administered easily if they were offered to small consumers, often the poor households and those without flush toilets. For example, a stepped tariff would have two advantages:-

(a) it would encourage consumption of at least a minimum quantity of water;

(b) such consumption would be at the lowest possible economic cost.

342. The position and height of the step could be varied to alter the extent of the concession offered to small consumers.

343. If they were able to afford connection to the new system poor households would benefit significantly from reduced expenditure on water (compared with the high cost of water supplied by water carriers).

344. We believe it would be more appropriate therefore to discriminate between poor and rich households by subsidising connection costs. These costs are high and are likely to be a deterrent to poor households. Also there is a close relationship between achievement of the health objective and increasing the proportion of connected households.

345. This would be an easier system to administer and to control, since it would be necessary only to know the income of a household at the time of connection and not to monitor changes in household incomes over time.

Non-Domestic Consumers

346. We do not think that the NWSA can easily satisfy the income redistribution objective by cross-subsidising between non-domestic and domestic consumers since there is no guarantee that raising funds from non-domestic consumers to subsidise the poor would always be beneficial. As an example, the end result of charging high water charges to shops might be an increase in the prices charged to the shops' customers, which could adversely affect the poor.

347. On the other hand, in the manufacturing and construction industries the cost of water is an insignificant proportion of the total costs of production. Higher charges could be levied in these sectors without having a serious effect on prices generally. However, since these sectors only consume small volumes of water compared to domestic consumption, the impact of such a cross-subsidy is likely to be negligible.

FINANCE

348. The financial objective is to recover the full costs of operation (including debt charges and depreciation on a renewal cost basis) over the period 1981 to 1990 as a whole. The Authority can therefore carry forward losses made in early years when the numbers of connections are small and water and sewerage revenues are low, and recover them from consumers in later years. Policies that maximise the number of connections and maximise water consumption will minimise the cost per household or business and increase their ability to pay for improved services.

SECTION VIII - RECOMMENDED TARIFF POLICY

349. This section discusses the selection of an appropriate tariff and connection policy to satisfy the aims set out in Section VII, the levels for such tariffs based on the analysis of Section VI, and then summarises our tariff recommendations.

350. The objectives to be met in determining charges for water are more complex than those for sewerage charges. In our analysis we have kept the two prices separate, and consider this is an appropriate policy for the Authority to pursue (although customers would only be billed once). This would permit consumers to purchase water service alone, without a cost penalty, if they could not afford sewerage service or if they had an acceptable private sewerage service.

351. If prices were combined to persuade consumers to take both services, this might adversely affect water consumption (by artificially raising the price of water) without necessarily increasing connections to the sewerage system. Because the health objective is so important, we suggest it would be more appropriate to encourage connection to the sewerage service by legislative means.

RECOMMENDED TARIFF STRUCTURE

352. The following paragraphs discuss the basis for charging for water and sewerage services in the domestic, commercial and industrial markets which the Authority serves, and the costs of connection.

Water Service

Domestic Consumers

353. The best overall achievement of the objectives results from a stepped tariff which is low enough to encourage all households to consume a minimum volume sufficient for their

basic needs, but which rises sharply to discourage wasteful consumption and to reflect the high cost involved in collection and treatment of waste water.

354. The level and structure of the tariff should be such that:-

(a) small families or those without flush toilets are not penalised;

(b) socially undesirable uses are nevertheless discouraged;

(c) a revenue surplus is generated to reduce monthly sewerage charges.

355. A stepped tariff would reduce the total monthly amount spent on water services by small and medium size consumers compared with payment of a single rate water tariff. It therefore benefits those households whose consumption is likely to be income constrained and those on the point of deciding to connect to the water service. Conversely larger consumers pay more in total with a stepped tariff than with a single rate tariff, but the additional costs are not so great as to significantly constrain the demand for water.

Non-Domestic Consumers

356. Under this heading we include institutions (e.g. schools, hospitals), commercial and industrial establishments.

357. We suggest that there should be two rates for non-domestic users. Water for standard rate non-domestic users (institutions, shops, etc.) should be the same price as that for domestic consumers. It would be undesirable if schools, for example, were deterred from using large volumes of water by a penal charge. On the other hand it would be inequitable if they did not contribute to the high costs of disposing of waste water.

358. A single rate structure for domestic users and small businesses (as at present) simplifies the problem of billing where a single connection serves more than one customer or type of use.

359. Other non-domestic consumers should be charged entirely at the higher rate:-

(a) if their demands are not likely to be deterred by a higher unit charge; and

(b) where such charges would not distort the level of end-product prices to the consumer (manufacturing, construction); or

(c) where the demands may be price-sensitive but are non-essential and could be constrained in order to conserve supplies (car wash businesses, public gardens, street cleaning).

Sewerage Service

360. The basis for charging for sewerage service can be very much simpler than for water service, since the costs to be recovered each year are virtually fixed (interest and loan repayments, depreciation) and there is only a single aim: to maximise the number of connections.

361. We suggest that the simplest method to achieve this is to charge a monthly fee to all households and businesses receiving the sewerage service; this would be a fixed charge unrelated to use.

362. As with water service, the Authority has the option of charging all customers the same monthly fee, or, if some are likely to be less price sensitive, of charging one class of customer more than another. In this case we suggest charging

all customers the same fee; although industrial users may be able to pay a higher fee, there is no evidence to suggest that their decision to connect is any less price sensitive than any other market sector for what is in practice an optional service.

363. If it were possible to enforce an obligation on all building owners to provide adequate toilet facilities (see below) then a discriminatory charging policy would have a greater chance of success, but would not be of commercial significance because of the small number of non-domestic customers.

364. A fixed charge would meet the social and economic objectives of the service since it would:-

(a) recover its costs only from those receiving it; and

(b) represent its real costs to the individual.

365. Nevertheless, since the sewerage system is very expensive and is financed by loan funds, the high costs to individual consumers may well deter many potential users from connecting. Achievement of the community health benefits of the project is dependent on there being a satisfactory level of connection to both water and sewerage services. We recommend therefore that the increase in water sales revenues resulting from the higher rate tariff should be used to reduce the sewerage charge; such a policy would bring consumption of the two services more into balance, while ensuring that the Authority did not exceed its financial requirement to break even.

Costs of Connection

366. For both water and sewerage services, the health and welfare objectives will be met by encouraging the maximum possible level of connection by domestic and non-domestic consumers. High connection levels also have the advantage

of spreading the fixed costs of the two systems as widely as possible, and reducing the costs of using the service to individual consumers.

367. From a financial point of view, the connection charges should cover the connection costs to avoid increasing the cost of the service and deterring marginal consumption. For new properties these costs would be met as part of the construction costs. For existing dwellings and small businesses, however, the number of connections might be increased by charging consumers in line with their ability to pay. We noted in Section VII that it would be easier to discriminate between rich and poor through the connection charge than through the monthly service charge.

368. We have considered three types of concession:-

(a) grants to reduce connection costs;

(b) an extended payment plan;

(c) shared connections.

These are discussed in turn below. The latter two options could also be offered to small businesses to increase the connection level.

369. In general we believe it is more efficient in terms of assisting a particular target group, and less expensive for the Authority, to offer specific concessions of this kind, rather than to subsidise the cost of connections for all new consumers. We discuss the problem of administering this policy in Section IX.

Grants

370. We suggest that a grant for all or part of the cost of new connections to the water and sewerage systems should be offered to the poorest 30% of households (ranked according to per capita incomes).

371. The level of grant might be set, for example, so as to reduce the cost of a water or sewerage connection to the same proportion of household income as a household with average earnings. This implies different levels of grant according to income.

372. Subsequent review of the working of such a policy may alter the income level at which concessions apply or the levels of grant offered, depending on the financial consequences and the extent to which eligible households take advantage of the concessions.

Extended Payment Plan

373. Although grants would benefit the poorest households, middle income groups would have to face the increase in connection costs without assistance. We believe one of the main obstacles to connection would be finding the large lumpsum payment - this would at best defer connection for some households and businesses while they saved, at worst it might deter them from connection.

374. We therefore suggest that an extended payment plan should be introduced to allow monthly payment of connection costs over, say, two years. This would enable payment out of future incomes rather than out of accumulated savings and might speed up the rate of connections; conversely the period would not be so long that a large number of connections might not be fully paid for because the household moves away. The same payment plan could apply to the proportion of costs which poor households have to pay.

Shared Connections

375. Another option the Authority might consider would be to encourage joint connections with a neighbour; this would significantly reduce the costs of connection. This would be easiest for water, where a single metered connection to the

distribution network might provide piped water into two or three dwellings - albeit with some reduction in the level of service. Similar arrangements involving shared facilities would be possible with sewerage service.

376. Whilst these options might cause some administrative difficulty for the Authority, we are confident that the problems can be resolved.

Summary of Recommended Structure

377. Diagram 5 summarises the relationship between the separate elements of the charging policy which we have developed in this section.

RECOMMENDED TARIFF LEVELS

378. The following paragraphs develop the analysis of Section VI in terms of the tariff policy recommended above and then summarise the recommended water and sewerage tariffs in each of the main sectors of demand.

Development of Recommended Water Tariff

Choice of Minimum Unit Charge

379. The analysis of the base case suggested that a price of 2.60 Rials per cu.m. would be necessary to meet the costs (in 1977 prices) of the first ten years of operation of the expanded water supply system.

380. The sensitivity analysis which was carried out showed that variations in a number of cost and demand assumptions could significantly affect the base case tariffs. Cost variations could increase the average tariff to 3.30 Rials, and variations in demand or in connection rates could increase it to 3.60 Rials or 3.30 Rials.

Diagram 5 - Summary of Recommended Tariff Structure

Water	Sewerage	Connection Costs
Variable charge related to consumption	Monthly fixed fee for use	Contribution from new users towards costs
Domestic: stepped tariff; Non-domestic: stepped tariff for small businesses and institutions; premium tariff for industry	Offset some costs against water tariff; review possibility of further reduction in capital charges	Subsidy to poor households; spread payment or shared connection options for others

381. As a result we believe it would be prudent to charge an average price of at least 3 Rials/cu.m. to protect the Authority from uncertainty in the base case forecasts, particularly since this involves anticipating customer responses to changes outside the current range of experience in Taiz.

Choice of Stepped Tariff Level

382. We considered the effect of increasing water tariffs for consumption over five cu.m./month to 4 Rials, 5 Rials and 6 Rials/cu.m. Although this would reduce the monthly sewerage charge significantly, it could constrain water consumption for small households without a flush toilet (often the poor households).

383. We then considered the effect of raising prices over 10 cu.m./month; Table 15 shows the average domestic water consumption and the monthly water bill. The higher the price that is charged for water, the larger the surplus that is available to offset sewerage costs. The three higher rate tariffs we considered would increase the monthly surplus, and therefore reduce the sewerage charge, by 3.70 Rials, 7.00 Rials and 9.80 Rials respectively.

384. Diagram 6 compares the size of the domestic water and sewerage bill at different levels of water consumption, with and without the stepped tariff. Our recommendation to set the higher water tariff at 6 Rials/cu.m. is intended to minimise the monthly sewerage charge, and to minimise the total cost of services for small and medium consumers.

385. It is unlikely that any significant additional reduction in sewerage charges could be achieved without imposing a major constraint on demand for water; and any further steps in the water tariff would reduce the contribution to sewerage charge and could delay the point at which customers pay the full costs of waste water disposal.

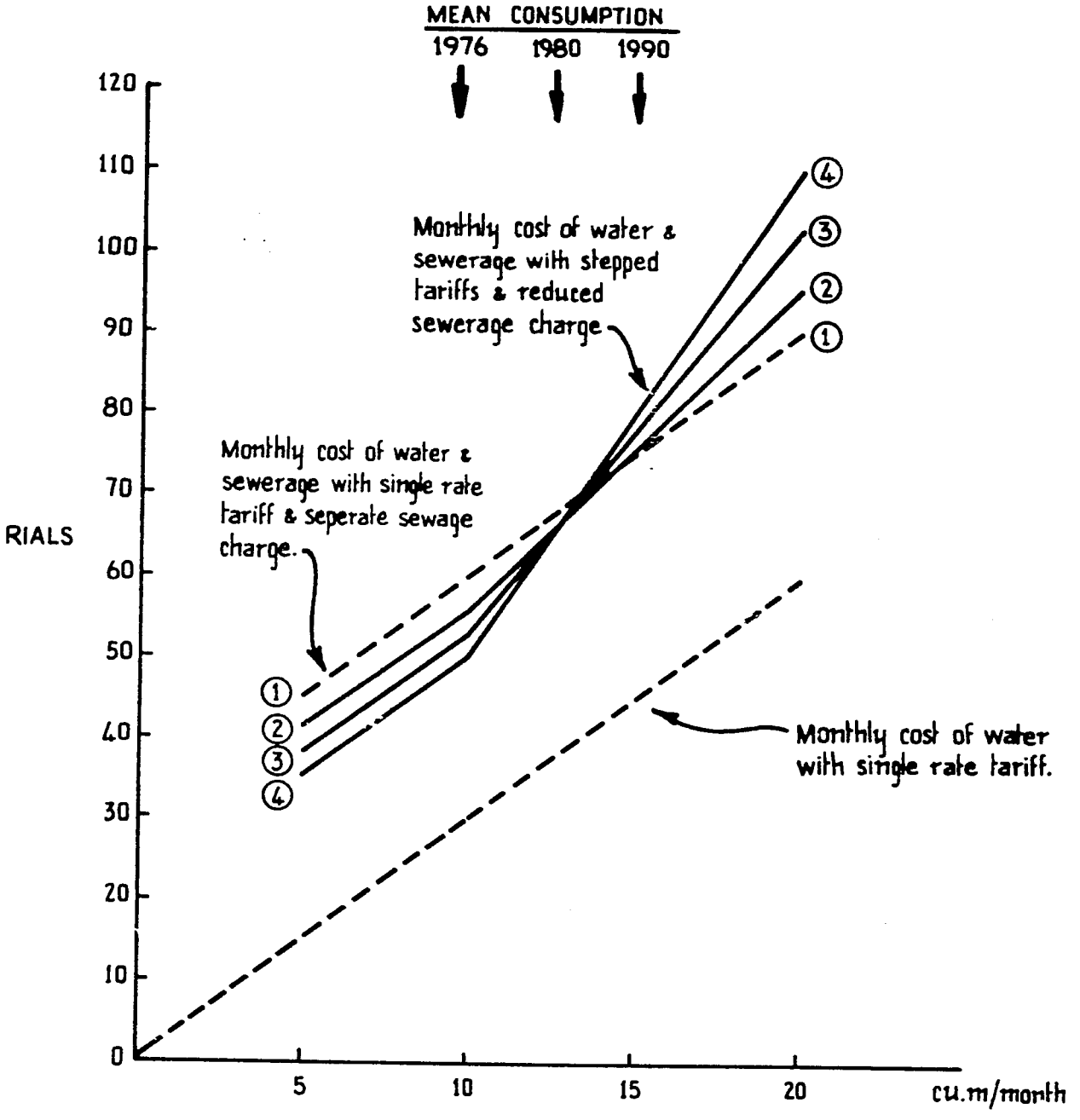
Table 15 - Development of Recommended Strategy

1. Price per unit (Rials):				
up to 10 cu.m./month	3	3	3	3
over 10 cu.m./month	3	4	5	6
2. Surplus (Rials/connection/month)	5.20	8.90	12.20	15.00
3. Average domestic water bill (Rials/month)				
1981	35.30	38.20	40.80	42.90
1985	39.30	42.50	45.40	47.80
1990	45.50	49.20	52.60	55.30
4. Domestic consumption (l/c/d)				
1981	67	66	65	64
1985	74	73	72	71
1990	86	85	84	82
5. Additional sewerage charge (Rials)	30	26	23	20

Note: The average bill and domestic consumption data for the stepped tariff options are more approximate than other, similar estimates in this report; they are calculated as if a single weighted average price was charged (respectively 3.30, 3.60 and 3.80 Rials).

Diagram 6

AVERAGE DOMESTIC WATER & SEWERAGE BILL UNDER ALTERNATIVE CHARGING POLICIES



PRICE OPTIONS:

① Single rate tariff at 3 Rials/cu.m; sewerage charge 30 Rials/month.

Stepped tariffs from 10 cu.m./month & reduced sewerage charge:-

② 4 Rials/cu.m., 26 Rials/month

③ 5 Rials/cu.m., 23 Rials/month

④ 6 Rials/cu.m., 20 Rials/month

Development of a Recommended Sewerage Tariff

386. In the base case the monthly sewerage charge was estimated at 26.50 Rials. The sensitivity analysis in Section VI indicated that it might vary between 18 and 29 Rials with variations in the cost assumptions, and between 20.50 and 37.50 Rials with variations in demand assumptions. Without a stepped water tariff it would be prudent for the Authority to charge a monthly fee of 30 Rials to allow for uncertainty in the forecasting assumptions.

387. However Table 15 shows that setting the higher water tariff at 6 Rials a cubic metre would increase the revenue surplus and allow the sewerage charge to be reduced to 20 Rials a month.

Review of Level of Sewerage Charges

388. No further comment on sewerage charges is required by our terms of reference. However, the magnitude of the sewerage charge which would result from the capital cost and loan terms we were given is such that we feel some additional comment is desirable.

389. The socio-economic surveys show that households and businesses with existing sewerage connections pay nothing for the service; even those which use a neighbour's or a public toilet pay on average only 10 Rials a month. A charge of 20 Rials/month for an improved level of service might therefore be a deterrent to connect to the system.

390. If a cheaper design for the system were to be adopted, or if the revenues were raised from other sources, this problem would not arise. (It can be argued, for example, that such social capital should be financed by the community at large since the public health benefits accrue to everyone.) We

have therefore considered the feasibility of changes in the base case assumptions to reduce the level of charge further.

391. Major reductions could only be achieved by either:-

(a) adopting a significantly cheaper design for the sewerage system; or

(b) increasing the equity funding for the sewerage project, either by increasing total equity or by switching equity from the water project; or

(c) paying some of the debt charges from an alternative source (central government, the municipality or the Taiz Co-operative); or

(d) funding extensions to the secondary collection system from sources other than revenue.

392. For example, to reduce charges for the new system by 5 Rials/month, the following changes to the base case assumptions would be necessary, either:-

(a) a reduction of 30% in the capital cost of the system; or

(b) an increase in equity finance for the sewerage project from $8 million to $16 million; or

(c) average annual payments of $0.4 million from 1981 to 1990 from a source outside the NWSA; or

(d) provision of additional loans of $4.0 million to fund 50% of the costs of extending the secondary collection system.

393. We do not know whether or not such charges are feasible. However, if the costs of the sewerage service were to be funded from inside Yemen, we suggest that changes in the rates and coverage of the sales taxes, which provide revenue for the central government and the Taiz Co-operative, might be considered.

Development of Recommended Connection Policy

394. In Section V we showed that the costs of connection to the improved services would be 600 Rials for water and 600 Rials for sewerage. These costs represent increases of 70% and 50% respectively over present average costs estimated by KMWS.

Target Level of Connections

398. In Section IV we estimated the proportions of households and businesses willing to connect to the new water and sewerage systems, given the present (1976) costs of such connections. However with higher costs of connection, fewer establishments would be willing to connect.

396. If we assume a price elasticity of demand for connection of 0.5 (the same as the income elasticity of demand for water derived from our survey data), then we estimate that the proportions of establishments wishing to connect would fall to the following levels:-

	Water	Sewerage
Households:		
at 1976 costs	70%-90%	60%-75%
at estimated costs	45%-60%	40%-50%
Businesses:		
at 1976 costs	45%-72%	40%-60%
at estimated costs	30%-50%	25%-45%

(The sewerage connection levels have been scaled down to a maximum 85% of the water connection levels to represent more feasible targets.)

397. These target connection levels would clearly not meet the health objectives discussed in Section VII. We have therefore examined the effect of concessions on connection costs for poor and medium income households on increasing the proportion of the population with access to adequate services.

398. In total we estimate that the concessions discussed below might increase the proportions willing to connect to services to:-

	Water	Sewerage
Households	65%-80%	55%-70%
Businesses	50%-70%	40%-60%

In each case, the lower proportion represents our estimate of the present proportion willing to connect in 1981, and the higher figure represents a 1990 connection level when attitudes change. These targets would meet the AID connection objectives described in Section I.

399. These levels might be exceeded depending on:-

(a) the level of service available from alternative water sources;

(b) whether private sewerage systems are permitted;

(c) whether the Authority exceeds the recommended target connection rates, particularly in the early years (see paragraph 419);

(d) whether services are incorporated in new properties as they are built;

(e) the effectiveness of our proposed public health legislation (see Section IX).

Concessions on Connection Costs

400. We discuss in turn the possible effects of each type of concession discussed above.

(a) Grants

401. The following levels of grant would reduce the cost of connection for poor households to 60% of monthly household income for water and 65% for sewerage - the same proportion as for a household with average income paying the full cost of connection:-

Poorest	1% to 10%	100% of connection cost;
	11% to 20%	70% of connection cost;
	21% to 30%	35% of connection cost.

402. The number of levels of grant proposed here are merely indicative and would need to be reviewed after experience of operating the policy has been gained (see paragraphs 363 and 364). In practice the number of alternative levels of grant offered is likely to be limited by administrative considerations.

403. At these rates we would expect an increase in the proportion of households wishing to connect of at least 10% to water and sewerage services.

(b) Extended Payment Plan

404. We estimate that an extended payment plan would reduce the cost of connection to 26 Rials/month for water and 30 Rials/month for sewerage. It is not possible to determine the likely effect of this concession on the proportion willing tc connect, but we would expect an increase of at least 5% for both water and sewerage services.

(c) Shared Connection

405. We estimate that the effect of permitting shared connections might be to increase the proportion of households and businesses connecting to improved services by up to 5%.

SUMMARY OF RECOMMENDATIONS

Domestic Water

406. We recommend that the price per unit (in 1977 values) should be:-

up to ten cu.m./month: 3 Rials/cu.m.;
over ten cu.m./month: 6 Rials/cu.m.;

and that there should be no monthly fixed charge.

407. A low water price for the first ten cubic metres:-

(a) meets minimum health needs at the lowest feasible tariff;
(b) is reasonable in relation to present prices, given the greater availability and better quality of water supplies;
(c) may reduce present levels of expenditure on water for poorer households at present buying from vendors;
(d) covers the full costs of provision.

408. A higher unit price over ten cubic metres:-

(a) discourages wasteful use;
(b) provides a contribution to sewerage costs at levels of consumption at which waste water disposal could become a health problem;

(c) reduces the fixed monthly charge for sewerage, which otherwise might deter households and businesses from connecting to the sewerage system;
(d) tends to increase expenditure on water by richer households, who are more able to pay and are more likely to consume large quantities of water.

409. The absence of a fixed charge:-
(a) minimises the cost to low consumers (often the poor households or businesses or the most price sensitive);
(b) avoids any further discouragement to connection, given that the costs of connection are already substantial.

Domestic Sewerage

410. We recommend that households connected to the sewerage system should pay a fixed monthly charge of 20 Rials (in 1977 values), and that there should be no charge related to use.

411. This monthly sewerage charge:-
(a) is the minimum required to achieve the financial objective given the contribution from higher rate water tariffs;
(b) is less likely to deter use of the service than a charge based on the full cost of sewerage (YR30).

Domestic Connection Costs

412. We estimate the cost of a water connection at 600 Rials and the cost of a sewerage connection at 660 Rials (in 1977 prices). We propose that there should be the following concessions on connection costs:-

(a) payment over two years (that is at 28 Rials/month for water and at 30 Rials/month for sewerage);

(b) a grant to poor households to reduce costs, at the following rates:-

poorest	1% to 10%:	100% of connection cost;
	11% to 20%:	70% of connection cost;
	21% to 30%:	35% of connection cost;

(c) shared connections should be permitted.

413. These connection concessions:-

(a) are necessary if a sufficient proportion of households are to be connected to achieve the health objective;

(b) are a better and more practicable method of helping poor households than concessions on monthly service charges.

Non-Domestic Water

414. In Section VII we defined two groups of non-domestic customers:-

(a) standard rate consumers: schools, hospitals, shops, offices, restaurants, hotels, etc., whose

demands are likely to be price sensitive or where above average prices may affect end-product prices;

(b) premium rate consumers: manufacturing industry, car wash businesses, construction sites, electricity generation, etc., whose demands are not price sensitive or where it is desirable to constrain excessive demands in order to conserve water.

415. We recommend that the price per unit of water should be:-

(a) for standard rate customers:-

up to ten cu.m./month: 3 Rials/cu.m.;

over ten cu.m./month: 6 Rials/cu.m.;

(b) for premium rate customers all consumption at 6 Rials/cu.m.

In both cases there should be no monthly fixed charge.

416. The advantages of adopting this tariff structure for standard rate customers are the same as for households. In addition, a common tariff for households and small businesses simplifies charging and revenue collection where supplies might be used partly for domestic, partly for commercial use (e.g. where a shopkeeper lives over his shop).

417. The advantages of adopting this structure for premium rate customers are:-

(a) a simpler tariff structure;

(b) industry can afford to pay more;

(c) higher charges cover the cost of waste water disposal;

(d) higher charges discourage waste.

Non-Domestic Sewerage

418. We recommend that the monthly sewerage charge should be 20 Rials/month for both standard and premium rate customers, and that there should be no charge related to use.

419. The advantages of this proposal are the same as for households. In addition, a single charge for all accounts will simplify customer accounting, which would be based on the number of connections.

Non-Domestic Connection Costs

420. For standard rate customers we propose the following concessions on connection costs:-

(a) payment over two years (at 28 Rials/month in 1977 values for water and at 30 Rials/month for sewerage);

(b) shared connections should be permitted.

421. These connection concessions are necessary if a sufficient proportion of businesses are to be connected to achieve the health objective.

422. We anticipate that premium rate customers are better able to pay. We therefore recommend that no concessions are permitted, and that to simplify administration the cost of connection should be paid in a single lumpsum at the time when the connection is constructed.

SECTION IX - ADMINISTRATIVE AND FINANCIAL IMPLICATIONS

423. This section summarises a number of administrative and financial implications of our recommendations and proposes subsidiary policies which the Authority should adopt in the following areas:-

(a) connection programme;
(b) public health legislation;
(c) administration of concessions;
(d) cost of concessions;
(e) projected revenues and costs;
(f) tariff revisions;
(g) customer credit.

ANNUAL CONNECTION PROGRAMME

424. To achieve the target level of connections in Section VIII we estimate that, on the base case growth assumptions, the Authority should:-

(a) increase the number of water connections by 5,500 by 1981;
(b) maintain an annual connection programme of at least 3,000 water connections from 1981 to 1990;
(c) increase the number of sewerage connections by 10,000 by 1981;
(d) maintain an annual connection programme of at least 2,700 sewerage connections from 1981 to 1990.

425. This programme includes increasing the provision of free public taps and toilets to the following levels (see Section IV):-

	Taps	Public Toilets
1976	55	46
1981	130	160
1990	190	290

426. This programme is essential to achieving the health objectives of the project. It may be that, to bring forward achievement of the health objective, they would wish to connect more establishments than this in the early years. This would also have a beneficial effect on the Authority's revenues.

427. We suggest that the Authority would maximise achievement of the health objective if it gave priority to connecting those households and businesses without any form of sewerage service, either publicly or privately owned, before converting establishments which already have some kind of private service (although some view would have to be taken of the acceptability, in public health terms, of permitting private systems to remain for any length of time).

428. The Authority should monitor the growth of Taiz and the growth in consumption per connection, however, to determine whether or not this connection policy remains adequate to meet the potential demands for services.

429. If the growth of Taiz is slower than assumed in the base case, we suggest they maintain the minimum connection programme proposed, and exceed the target levels of service. If on the other hand the growth of Taiz is faster than we have assumed, and if the Authority cannot increase the rate of connections to keep pace with it, then we suggest they should alter the target levels of service to give priority to households, institutions and industry in that order, and, within the household sector, to water connections rather than sewerage (although the two should not be allowed to get seriously out of balance - i.e. the proportion of those with water service also connected to the public sewerage system should not fall below about 50%).

PROPOSED LEGISLATIVE PROGRAMME

430. It may be, however, that concessions alone will not be sufficient to encourage a sufficient proportion of households and businesses to connect to improved services to raise standards of public health in Taiz. We therefore recommend that the Authority and the municipality should take various legal steps to reinforce the commercial policy outlined above. We consider in turn the control of competing water and sewerage services and the introduction of various public health ordinances and building regulations.

Control of Private Water and Sewerage Services

431. We do not consider that competing water services should be banned. In the short term they will be necessary to supply those households or commercial establishments which do not have their own connection to the Kennedy system. In the long run they may be useful as a supplementary source to meet shortages in the Kennedy supply if that supply is still limited. Of course, if there is no future supply constraint, the alternative water sources can be expected to disappear, other things being equal, through normal commercial competition.

432. These sources should only be closed down if the water supplied is of such a poor quality as to cause a hazard to public health. In this event the water source should be physically sealed by the water authority, and steps taken to ensure that no other outlet remains open.

433. Conversely, as far as alternative sewerage facilities are concerned, in our view no alternatives should be permitted to exist unless specifically licensed by the sewerage authority. This would entail by, say, 1985:-

(a) the physical inspection of all septic tanks and cesspits to determine their effectiveness and any potential hazard to public health directly or through proximity to the public water supply;

(b) the creation of a register of approved structures, and periodic inspection to ensure that standards of such structures are maintained;

(c) the destruction by the sewerage authority of those structures which cannot be put into an acceptable condition, accompanied by the payment of compensation, where appropriate.

Municipal Ordinances and Building Regulations

434. In addition to the measures described above, we believe that certain legal measures, with appropriate administrative penalties, should be considered to reduce existing public health hazards and to establish clearly the responsibilities of the public for connecting to suitable services and for conserving water.

435. Seven articles are proposed:-

(a) to prohibit defecating in the streets or on open land within the city boundary;

(b) to make owners of existing dwellings and business premises employing more than five persons responsible for:-

(i) making sufficient connections to the public water supply and to an approved sewerage system to meet the needs of all the occupants of the building;

(ii) making them accessible to all the occupants of the building; and

(iii) maintaining them in working order;

such connections to be made by, say, 1985;

(c) to ensure all new dwellings and business premises are constructed with connections to the public water supply and to an approved sewerage system;

(d) to restrict the construction of all temporary structures to be used as living quarters to areas where access to public standpipes and public lavatories is, or can be, easily provided by the municipality;

(e) to control the wasteful use of water (particularly in activities which consume large volumes of water - gardens, street cleaning, construction, washing cars);

(f) to introduce a system of regular inspection of all establishments concerned with the manufacture, preparation or sale of food or drink to the public and of all hotels and public lodging houses to ensure that adequate water and sewerage services are provided and are in working order;

(g) in the absence of action by landlords on article (b) above within an agreed time, to permit tenants of rented dwellings to deduct from their rent the costs incurred in the provision and maintenance of appropriate services on their own account.

ADMINISTRATION OF CONCESSIONS ON CONNECTIONS

436. Introduction of a new series of concessions will create new administrative problems for the authority. At present grants are provided to poor households by the Taiz Co-operative to cover part of the costs of connection to the sewerage system, based on local knowledge of need. This system could be formalised and records kept relatively easily.

437. Clearly the procedures that are established should take account of all the relevant circumstances of households applying for concessions - household size, wealth, incomes, mobility, housing tenure, for example - as well as proximity to other free public water and sewerage services. However, they must also be practicable.

438. From experience gained with the socio-economic survey and from discussions of the Co-operative's present procedures we believe that it should be possible to form a sufficiently accurate judgement of household incomes to administer such a policy, from direct interviews with the applicant and from local knowledge, provided the number of alternative grant levels is limited. The criteria for determining the level of grant are set out in Section VIII.

439. As far as the extended payment plan is concerned the Authority will have to control customer credit closely. In cases of default, the Authority may continue its existing policy of withdrawing water service until the outstanding debt is paid. If however a customer has left Taiz the Authority may have to seek repayment from the new occupant of the connected premises or from a landlord. (The repayment period is limited to two years to minimise the number of such cases.)

440. Existing customer record cards and bill pro formas will need to be altered to handle the increased complexity of monthly invoices.

COST OF CONCESSIONS ON CONNECTIONS

441. With the concessions proposed above, we estimate that about 30% of all households will require some assistance with connection costs. In order to reduce costs relative to income to the same proportion as for an average income household then:-

(a) 15% of households will require a 100% grant;
(b) 10% will require a 70% grant;
(c) 5% will require a 35% grant.

442. Taking the average sewerage connection cost as YR660 and the average water connection cost as YR600 implies that the grants will cost YR850,700 each year. This cost might have to be met by the Water Authority though it could be met by the Taiz Co-operative which already gives some poor families grants towards connection costs.

443. We estimate that about half of the remaining applicants for water or sewerage connections (i.e. 35% of the total) will opt to pay by instalments. With approximately 3,000 water and 2,700 sewerage connections made each year the average total balance on instalment accounts will build up over two years to YR630,000 for water connections and YR623,700 for sewerage connections.

444. If the instalment accounts are funded by borrowing on commercial terms (20% per annum) the annual interest costs will be YR126,000 in respect of water connection accounts and YR124,700 in respect of sewerage connection accounts. In Section V of this report we recommended that the Authority should seek to recover only half of these interest costs.

PROJECTED REVENUES AND COSTS

445. Table 16 shows:-

(a) the revenue that would be generated each year by the recommended tariff structure;

(b) total water and sewerage base case costs (excluding the costs of financing instalment accounts and grants);

(c) base case costs excluding depreciation.

446. The table reveals that although total accumulated costs will exceed revenues until 1990, the large depreciation provision means that the Authority will be able to generate a substantial positive cash flow from the inception of the new system.

TABLE 18 - PROJECTED REVENUES AND COSTS

YROCO

	REVENUES			TOTAL COSTS		COSTS LESS DEPRECIATION	
	WATER SALES	SEWERAGE CHARGES	TOTAL	ANNUAL COSTS	ACCUMULATED SURPLUS/(DEFICIT)	ANNUAL COSTS	ACCUMULATED SURPLUS/(DEFICIT)
1981	10,810	3,500	14,310	15,452	(1,142)	11,412	2,898
1982	12,801	4,195	16,996	16,203	(349)	12,095	7,799
1983	14,706	4,888	19,594	19,030	215	14,853	12,540
1984	16,379	5,583	21,962	26,219	(4,042)	21,974	12,528
1985	18,167	6,278	25,445	28,433	(7,030)	24,119	13,854
1986	20,196	6,972	27,168	30,003	(9,865)	25,620	15,402
1987	22,434	7,666	30,100	30,384	(10,149)	25,933	19,569
1988	25,086	8,361	33,447	30,494	(7,196)	25,974	27,042
1989	27,758	9,056	36,814	30,688	(1,070)	26,100	37,756
1990	30,806	9,750	40,556	31,046	8,440	26,389	51,923

NOTE: Costs and revenues are derived from the recommended tariffs and connection programme, assuming base case costs and growth in demand.

The internal rate of return on the combined project is 6.33% (in real terms) over the period 1977 - 2001

TARIFF REVISIONS

447. The tariff levels recommended in this report should be regarded as provisional in that:-

(a) the terms of financing for the project are still unknown;

(b) the real capital and operating costs are likely to differ from Hazen and Sawyer's estimates;

(c) our projections are expressed in March 1977 prices and do not allow for inflation.

448. Tariff levels should be revised from when tenders are received and financing agreed. Thereafter tariffs should be revised at least annually and possibly more frequently if high rates of inflation should be experienced.

449. Ideally the Authority should draw up budgets each year to act as a means of cost control and also to form the basis for tariff revisions. If, however, this is not done then the tariff rates should be linked to the general price index (this method is less satisfactory since the change in a consumer price index need not directly reflect the movement in the Authority's costs).

450. Whilst the Authority may wish to defer implementing our stepped tariff recommendations until the costs and loan terms are known or until the improvements are complete, we suggest that some immediate increase in the water tariff is desirable to cover the existing production costs (see Table 1), and to reduce the eventual increase from the present tariff level to the level recommended by our, or subsequent, analysis.

451. In the past the Authority has not revised its tariffs often enough or by adequate amounts. The result has been that revenues have been insufficient to cover the costs of

repairing and replacing plant and equipment and the system has gradually deteriorated. The regular revision of tariffs is essential to the Authority's long-term viability.

CUSTOMER CREDIT

452. At present the Authority requires a deposit from customers equivalent to three months' average consumption. We believe that to continue such a policy, in addition to the high costs of connecting, might deter some households and businesses from connecting. The Authority should weigh the risk involved in discontinuing this policy against achieving more connections when it has experience of the level of demand for connection particularly from poor households.

TARIFF STUDY
SCOPE OF SERVICES

Revised
April 20, 1976.

Taiz Water and Sewerage System
Yemen Arab Republic

I Introduction

The objective of the tariff study is to develop a tariff structure for the improved Taiz water and sewerage system, which meets certain social and equity needs of the public on one hand, and the financial requirements of the utility on the other. These criteria are described in Section VI, Formulation of Tariff Policy and Schedule of Changes. Given the paucity of knowledge concerning the population of Taiz, e.g. income, cost of living, family size, etc., and the acknowledged need for subsidisation of the improved system by the central government, a flexible approach to developing a tariff structure is required. The approach presented herein deals with both sides of the equation, and attempts to bring them into balance.

On one side, a socio-economic study is proposed, which would determine the various income ranges in Taiz, the number of families and other establishments which fall into these ranges, their pertinent characteristics, the amount each group can and will expend for water and sewerage services, their consumption needs, and ultimately, the amount of revenue that could be generated.

On the other side, the costs of the system must be determined, particularly as they relate to the variations of service that could be offered to the several income groups and classes of customers.

In the event that an acceptable tariff structure, in terms of charges, or availability or type of service is not possible for the given costs, it may be necessary to recalculate and readjust the terms of the financial assistance required by the Taiz system from the National Water and Sewerage Authority (NWSA), prior to finalising a tariff structure.

II Gather Base Data

In developing the socio-economic data base, the contractor shall review existing studies, adjusting these in light of changed conditions or assumptions in order to make use of the data. Included among these existing studies are the census data for Taiz, the limited data collected previously by the contractor in that city, and the observations of the engineering feasibility report (James M. Montgomery, Consulting Engineers Feasibility Study of Water Supply and Sewerage Facilities for Taiz, Yemen Arab Republic, Volume I, April 1975). In addition, the contractor shall develop additional sources of data required for this study. Such sources will include direct measures where possible, including water utility records, and the records of commercial/industrial and public users (including mosques). Indirect indicators will also be used, as for the similar study in Sana'a, as both a substitute where direct measures are not possible, and as a cross-check on other sources of information.

Data for the review of current water and sewerage service will be obtained through the water utility, and from the engineering feasibility study.

Specifically, these include the following:-

(a) socio-economic data:-

(i) household:

- income/wealth and expenditures by type of expenditure (including water);

- water consumption;
- source of and distance to water;
- sanitary facilities and service;
- housing conditions and tenure;
- size of household;

(ii) city population:

- in-migration (length of time in household);
- mobility (seasonal);
- number of households;
- size and composition of households;

(iii) industry and commercial establishments:

- source of water;
- sewerage service;
- water consumption;

(iv) public establishments and charitable institutions:

- source of water;
- sewerage service;
- water consumption;

(v) attitudes of households and non-domestic establishments:

- towards water service, sewerage service (present and future);
- towards hypothetical bills;

(b) review of water and sewerage service:-

(i) availability of water (e.g. sources, volume, hours of service, etc.);

(ii) methods of water distribution, protection, treatment;

(iii) availability of sewerage service (e.g. location, capacity, performance);
(iv) methods of sewerage collection and treatment;
(v) use costs, installation costs;

(c) data breakdowns - data collected will be broken down by the following:-
(i) presence and absence of water and sewerage service;
(ii) geographic area.

III Project Data for Determining Future Consumption and Ability to Pay

The contractor will make projections for ten years of project operation for pertinent items included in the base data collection, from the following major categories previously detailed in Section II:-

(a) households;
(b) city population;
(c) industry and commercial establishments;
(d) public establishments and charitable institutions;
(e) water and sewerage services.

The contractor's projections should be based upon the socio-economic survey in addition to data collected from other sources, development plans of the municipal and national governments, and commercial and industrial plans for expansion in Taiz.

Projected water supply and sewerage service is described in the feasibility study, and this information will be augmented by the design engineering contractor. The design engineer's input will be available to the contractor prior to their preliminary report.

IV Analyses

The contractor will tabulate data collected to establish the pertinent relationships between income/wealth, size of family, geographic location, source of water, water consumption, and the various other factors noted in Section II.

Based upon their data collection and observations the contractor will determine for various income/wealth groups, and classes of service, the amount that consumers can likely spend for water/sewerage, given such factors as water consumption and size of family (water demand should be calculated at no lower than the level required to meet minimum domestic needs in the case of households, or minimum needs relevant to other categories of service). Ability to pay may be expressed as an annual (or average amount per billing period) per connection, and per unit of water for the various income/wealth groups and classes of service. The contractor will indicate any problems in data collection or analyses.

V Capital and Operating Maintenance Costs

The capital cost estimate for Phase I of the expanded Taiz water and sewerage system will not be firmly established at the time the socio-economic data collection is begun. AID will supply the contractor with the following cost items which are to be prepared by the design engineering consultant:-

(a) construction and installation of project facilities;

(b) annual cost of replacement parts, materials and supplies needed for operation and maintenance of the system;

(c) length of service life of major components of the system.

The submission date of the contractor's preliminary report will be keyed to AID's delivery of cost data. The contractor will review the costs presented, and project these over the ten year period following inception of service under the improved system.*

To the extent that these are not adequately covered by the design engineer, the contractor will review the effect of inflation on estimated capital costs, as well as working capital such as stores of spare parts and materials for maintenance, connections, workshops, transport fleet, meters and office equipment. The operating costs in terms of depreciation and interest will be derived from the cost of construction, and installation of project facilities, and the service life of major project components. In reviewing the wage and salary costs over the specified ten year period, the contractor will consider the extent of reliance on expatriate skilled staff which may be necessary in the initial years, and the speed with which these may be replaced by Yemeni nationals. Other operating costs to be included in the contractor's projections include operating expenses such as the cost of power and chemicals, administrative outlays in addition to salaries, costs of commencing service and connections.

The contractor will consider, in making such cost projections, the implications of the various types of service which may be offered, particularly to lower income groups, e.g. metered house connections, unmetered house connections - with or without restricted orifice, public faucets, sewer connections, public toilets, waste depositories, etc. (Public toilets and

*Since the project cost data prepared by AID's engineers are only estimates and may be different from tendered costs to be received later, the contractor is expected to evaluate these cost estimates and report to AID any significant discrepancies which are likely to exist.

waste depository stations have been suggested, the former in the feasibility study.) However, the responsibility for construction and maintaining these has not been addressed. The contractor shall consider the social implications and any administrative problems connected with the various types of service. The Montgomery feasibility study suggested that the basis for a concessional rate be a 3/8" restricted orifice water meter, which would be offered to lower income families; this approach should be reviewed.

The Montgomery feasibility study also suggested that connection costs be paid in a lump sum by the subscriber, with the exception of those associated with the restricted 3/8" meter. These meters would be installed free of charge. For all other metered service, the subscriber would purchase a meter on the open market, pay the utility to install it, and assume the costs of running plumbing to the house from the meter. The contractor will assess the cost implications for tariff charges and revenues, and social objectives.

VI Formulation of Tariff Policy and Schedule of Charges

Based on the projected consumption levels and the ability to pay of the various levels and classes of users, and the financial needs of the utility, the contractor will develop a tariff policy which includes at least the following types of considerations:-

(a) schedule of charges:-
  (i) by income/wealth;
  (ii) by type of service;
  (iii) by geographic area (if applicable);

(b) type of service:-
  (i) by income;
  (ii) by geographic area;

(c) timing of service introduction (if applicable):-

(i) by type of service;

(ii) by rate level;

(iii) by geographic area.

(Certain aspects of the timing of the introduction of service and the geographic location of service, relative to the type of service of timing of its introduction, will be a function of the engineering rather than policy relating to social or financial considerations.)

As a public utility, it is assumed that NWSA/Taiz will attempt to balance its own needs with those of the public. Needs of the public include those of commercial, industrial and public establishments - both for maintenance and growth - and those of domestic users, who should be supplied with water and sewerage at the earliest date consistent with the utility's financial position. The Yemen Arab Republic's primary objective in improving the Taiz water and sewerage system is to improve the health of the people of that city. It is generally accepted that the least contamination and the greatest personal hygiene benefits are obtained where houses and other establishments are directly served by a potable water source. The contractor should therefore attempt to develop a tariff structure which assures that every household, commercial/industrial and public and charitable establishment within the service area will have physical and financial access to an adequate supply of water at the earliest possible time. A limited number of households and non-domestic buildings may be expected to depend on public faucets and the existing spring water system for water supply. The system shall also have the objective of having connected 60% of the population of Taiz to the sewer approximately seven years after the improved system goes into operation. These objectives correspond to the system's design capacity.

Needs of the utility include first, its obligation to meet the rate of return agreed upon NWSA and AID; and secondly, the need to provide financially for the renewal of the system. In developing a rate structure and revenue requirements, the contractor shall aim to achieve the required rate of return as an average over the ten year period following introduction of improved service. Contractor will submit annual income statements, cash flow and balance sheets for NWSA/Taiz showing the projected rate of return on average net fixed assets for the period extending ten years from the institution of the new service.

In arriving at tariff policy recommendations, the contractor should consider progressive water consumption needs. In summary, the following factors should be considered in arriving at equitable water/sewer charges:-

(a) recoupment of real costs;
(b) applicability of marginal costs;
(c) applicability of stepped tariff scales and tariffs based on fixed basic charges combined with unit charges on excess consumption;
(d) frequency of review;
(e) deposits as security against default in payment or damages to the system;
(f) a fair return on capital investment;
(g) future capital expenditure requirements;
(h) the relative contributions to be made by different classes of consumers in light of social and economic conditions.

In summary, the following factors should be taken into account in making financial projections:-

(a) long-term corporate plans;
(b) projected water consumptions, allowing for non-revenue earning consumption;
(c) estimated sales based on the proposed tariff structure;
(d) estimated direct costs and overheads;
(e) estimated capital expenditure;
(f) estimated working capital;
(g) renewal of fixed assets;
(h) sensitivity of results to changed assumptions of revenue and expenditure.

The contractor should examine alternative relending terms and project rates of return for the loan to NWSA, and provide a recommended level for each which is consistent with the socio-economic and financial requirements of the project.

The recommended tariff structure should be accompanied by guidance on the criteria and methods to be applied in establishing the eligibility of individual families (or areas, if applicable) for the various rates/types of service to be offered, particularly insofar as concessional service is concerned. For example, once criteria are established, can eligibility be determined by an interview, by appraised value of the dwelling, etc.? Guidelines should also be given for controls on the misuse of concessional service. Steps required to achieve the integrity of the system, such as levying charges against private wells might also be included where relevant. A certain percentage of citizens are connected to an independent water system, which although its quality may be questionable, may not be expected to desire to utilise the new system.

Guidelines concerning eligibility for concessional service should address the problem that an estimated 70% of the families in Taiz already have metered house connections, with 1/2" or 5/8" meters. Will some of these families who obtained service under a previous tariff structure be eligible for a different type of service, or a different rate - particularly the concessional rate? What provision should be made, if any, to assure that these families are not unnecessarily burdened once the new tariff structure is applied?

VII Reports

The contractor will submit a preliminary report which includes the following:-

(a) a description of alternative tariff policies;

(b) the financial and socio-economic implications of these alternative tariff policies especially with respect to income distribution, health and overall social welfare;

(c) a set of feasible alternative rates structures consistent with AID's and NWSA's financial and socio-economic requirement;

(d) the contractor's recommendation regarding the optimum alternative(s).

Should the contractor determine at any time, during preparation of the preliminary report, that AID's and NWSA's basic requirements for service are incompatible with the financial needs for the given costs, and not likely to produce acceptable tariff alternatives, the contractor may ask to submit an advance brief of findings for immediate review by AID, with a request for further instructions.

Following the review of the preliminary report by NWSA and AID, the contractor will receive comments regarding the choice of a tariff policy and rate structure. Should one of the alternatives meet the necessary requirements for the project, the preliminary report will essentially be the same as the final report. However, if none of the alternatives meets the requirements of AID and NWSA, the contractor may be required to make additional calculations under different assumptions.

THE TAIZ TARIFF MODEL

Introduction

1. As part of the tariff study for the city of Taiz, a computer program has been written which calculates the optimum rate of new connections to the water system, the unit cost of water and consumption per connection for a number of years, in a number of different market sectors. The program uses a technique similar to linear programming to ensure that various constraints are met and that the system gives the required financial yield.

2. The basic constraints that are input for each year are:-
   (a) the total capital and operating costs to be recovered;
   (b) the total volume of water available;
   (c) the number of connections in each sector at the start of the forecast period;
   (d) the maximum number of new connections that can be achieved;
   (e) the maximum and minimum number of new connections desired in each sector;
   (f) the relationship between price and consumer demand in each sector;
   (g) the maximum and minimum acceptable price levels in each sector.

3. The program follows a two-stage optimisation process. The first stage is to achieve the financial yield set in a particular year. If this yield is achieved, then the program will maximise the total connections in all sectors, subject to the constraints above. If the yield cannot be achieved the program maximises the revenue from the system and carries forward any deficit to the following year. Similarly, if revenues exceed the required financial yield, surpluses are carried forward.

4. If the supply of water is limited, water can be allocated between different categories of consumers to achieve one of four alternative objectives; these are:-

   (a) to maximise the number of new connections;
   (b) to maximise consumption by existing consumers;
   (c) to maximise revenue;
   (d) to minimise total expenditure per consumer.

   In each case the price levels appropriate to these objectives, the total volume of water demanded, total revenues and the numbers of new connections achieved are calculated for each market segment in each year. In practice only the first objective ensures that the system breaks - even at the end of the forecast period.

5. These constraints and objectives are defined in mathematical terms in the next two sections. The data used in calibrating and running the model was derived from the Taiz Socio-economic surveys and are discussed in Section IV of this report.

Constraints

6. We have assumed N market sectors in Taiz, and that forecasts are required for each of M years. (It should be noted that, although the model is set up in years, the period used could be any length (e.g. in quarters)).

7. With demand unconstrained by supply, then the demand q_i by a consumer in sector i (i=1,2,.....N) is related to the price p_i by a relationship like:-

$$q_i = (A_i - p_i B_i) \qquad \text{----- 1}$$

where A_i, B_i, are constraints relating to a particular segment. (A linear relationship is assumed here for simplicity, but it is not essential).

8. The total expenditure of a consumer in sector i who is connected for the whole year is therefore $(p_i q_i)$. However, new consumers are, on average, only connected for half the year so they pay $(p_i q_i/2)$ to the water authority.

9. If the number of consumers at the start of the year in sector i is u_i; and the number of new connections is t_i then the total expenditure by all consumers in that year is given by:-

$$\sum_{i=1}^{N} p_i q_i (u_i + t_i/2)$$

This is equal to the financial requirements of the water authority (Y), plus an excess or deficit (E). Hence:

$$(Y + E) = \sum_{i=1}^{N} p_i q_i \, (u_i + t_i/2) \qquad \text{----- 2}$$

The desired value of E is zero.

10. The total water consumed by all consumers must not exceed the quantity of water Q available from the system. Hence:

$$\sum_{i=1}^{N} q_i \, (u_i + t_i/2) \leqslant Q \qquad \text{------ 3}$$

11. In addition there are maximum and minimum constraints on the total number of connections in each sector, and a maximum constraint on the total number of new connections in Taiz in each year. These conditions may be written as:-

$$x_i \leqslant t_i \leqslant y_i \qquad (x_i \text{ is minimum and } y_i \text{ is maximum number of new connections desired}) \quad --- 4$$

$$\sum_{i=1}^{N} t_i \leqslant T \qquad (T \text{ is maximum number of new connections feasible}).$$

Objectives

12. Four alternative objectives are defined in paragraph 4 and are discussed in turn.

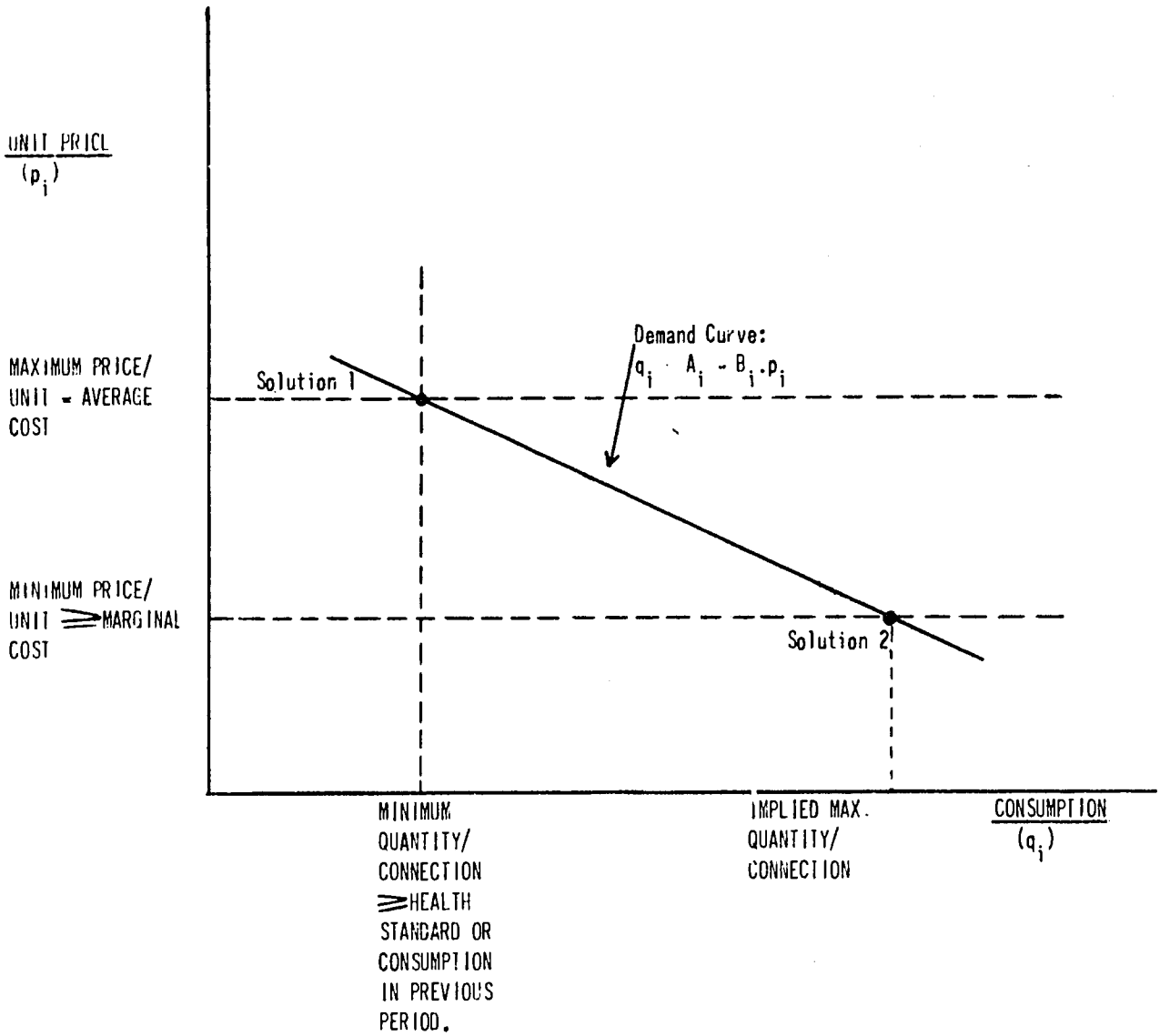
13. The maximum number of new connections is achieved by supplying each consumer with a minimum volume of water (consistent with health objectives). The actual volume is determined by setting the unit price of water equal to the average cost in equation (1) above. The program iterates through all years/sectors until the excess yield at the end of the forecast period is zero (or is within acceptable error limits).

14. Maximum consumption for existing connections is achieved by setting the unit price of water equal to the marginal cost of production in equation (1) (or some other lower bound, for example existing prices if it is essential that prices should increase). This also gives the minimum number of new connections that can be achieved.

15. The maximum revenue from the system and the minimum expenditure per connection are other price/volume solutions determined from equation (1). Since the demand curve we have assumed is linear, these two objectives yield identical solutions to those described in paragraphs 13 and 14 respectively. If the demand curve was non-linear additional, intermediate solutions would be identified.

16. The two key solutions determined in the Taiz tariff analysis are described diagrammatically overleaf for one market sector.

DIAGRAMATIC PRESENTATION OF DEMAND/SUPPLY INTERACTIONS IN i^{th} MARKET SECTOR IN m^{th} PERIOD



LIST OF VISITS MADE

A: Government Agencies

Central Bank of Yemen
Central Organisation for Control and Audit
Central Planning Office
General Staff Office
Highway Authority
Kennedy Memorial Water Authority
Ministry of Awkaf (Religous Affairs)
Ministry of Economy
Ministry of Education
Ministry of Finance
Ministry of Health
Ministry of Municipalities
Ministry of Public Works
Ministry of Social Affairs
National Water and Sewerage Authority
Taiz Co-operative
Taiz Electric Company
Yemen Bank for Reconstruction and Development
Yemen Tourist Corporation.

In many cases visits were made both to the head offices in Sana'a as well as to the branch offices in Taiz.

B: Other Bodies

Save the Children Fund Hospital, Taiz
UNIDO
USAID
Various Taiz businessmen and industrialists.

We would like to thank all concerned for their help and co-operation.

RESULTS OF TWO PART TARIFF ANALYSIS

The following tables present the results for the sensitivity tests described in Section V on the assumption that the Authority might wish to maintain its present unit price of water (2 Rials/cu.m.) and recover the increase in total costs through an increase in the fixed fee.

To provide the same margin against uncertainty as in our water tariff recommendations, the Authority would have to introduce a fixed fee of 13 Rials/month per connection (in 1977 prices).

TABLE 17 - SENSITIVITY TO CHANGES IN COST ASSUMPTIONS

(TWO PART TARIFF)

	CAPITAL COSTS		LOAN TERMS		WATER SUPPLY		OPERATING COSTS	
	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW
1. Price per unit (Rials)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2. Monthly fixed fee (Rials)	9.30	6.80	10.40	(1.30)	7.40	10.80(2)	10.50	4.70
3. Average domestic bill (Rials/month)								
1981	34.60	34.10	35.70	24.00	32.70	35.80	35.80	30.00
1985	37.60	35.80	38.70	27.00	35.70	38.80	38.80	33.00
1990	42.10	39.80	43.20	31.50	40.20	40.80(2)	43.30	37.50
4. Domestic consumption (l/c/d)								
1981	72	}			72	72	72	}
1985	80	} →		→	80	80	80	} →
1990	93	}			93	85 (2)	93	}

Table 19 - Sensitivity to Changes in Combinations Of Demand Assumptions (Two Part Tariff)

		Low Growth Low Demand	Low Growth High Demand	High Growth Low Demand
1. Price per unit	(Rials)	2.00	2.00	2.00
2. Monthly fixed fee	(Rials)	17.50	13.80	2,60
3. Average domestic bill	(Rials/ month)			
1981		42.80	39.10	27.90
1985		44.80	43.10	29.90
1990		47.50	49.10	32.60
4. Domestic consumption	(l/c/d)			
1981		73	73	73
1985		78	84	78
1990		86	101	86
5. % of water supply used				
1981		29	30	38
1985		47	51	68
1990		69	83	102
6. Total new connections per annum		2,100	2,100	3,640

Note The same proportions of households and businesses are connected as with an average cost price.

Table 20 - Sensitivity to Variations in Rate of Connection or Proportion Willing to Connect (Two Part Tariff)

		Rapid Build-Up	Inter-mediate Rate	Low Rate	Fewer Willing
1. Price per unit	(Rials)	2.00	2.00	2.00	2.00
2. Monthly fixed fee	(Rials)	7.50	10.50	15.30	11.00
3. Average domestic bill	(Rials/ month)				
1981		32.80	35.80	40.60	36.30
1985		35.80	38.80	43.60	39.30
1990		40.30	42.80	48.10	43.80
4. Domestic consumption (l/c/d)					
1981		72			
1985		80			
1990		93			
5. Total new connections per annum		4,500 1984	3,000	2,200	3,000

Note The same proportions of households and businesses are connected as with an average cost price.

Table 21 - Base Case with Alternative Contributions To Sewerage Costs (Two Part Tariff)

		All Sewerage	Lagoons	Half Sewerage	Debt Financed
1. Price per unit	(Rials)	2.00	2.00	2.00	2.00
2. Monthly fixed fee	(Rials)	32.30	28.60	20.00	24.80
3. Average domestic bill	(Rials/ month)				
1981		57.60	53.90	45.30	50.10
1985		60.60	56.90	48.30	53.10
1990		65.10	61.40	52.80	57.60
4. Domestic consumption					
1981		72			
1985		80			
1990		93			