# Instructor Guide Demand Forecasting

**DEMAND FORECASTING**

Instructor Guide

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## GENERAL INFORMATION FOR THE INSTRUCTOR

### Module Use and Content

The "Demand Forecasting" module may be used as an independent instructional unit, or in conjunction with the other modules in EDI's two-week seminar on "Water Supply and Sanitation." The module includes the following presentation materials:

- An Instructor Guide
- A Participant Manual
- A slide/tape program

### Time Required

The module is divided into four parts and requires approximately six hours to complete.

### Participant Manual and Instructor Guide

The Participant Manual contains all the information and instructions required to complete the module activities.

The Instructor Guide is organized so that Instructor Notes appear on the left-hand pages, opposite the Participant Manual pages printed on the right. (The Participant Manual pages in the Instructor Guide are identical to those in the actual Participant Manual.) The Instructor Notes include suggested time requirements, steps for conducting the module activities, discussion guidelines and suggestions on presentation. The time requirements are approximate, but following the suggested times will ensure that the module does not require more than six hours to complete.

The Instructor Guide and Participant Manual both contain reference copies of the visuals and the narrative text from the slide/tape program.

### Slide/Tape Program

Most of the instructional content for this module is presented in the slide/tape program, "Demand Forecasting." The slide/tape program includes 160 35mm slides which are synchronized with the narration on two accompanying audiocassettes.

The slides are inserted in carousel trays that most projectors will accommodate. The narration for Parts I and II is on the first audiocassette. The narration for Parts III and IV is one the second audiocassette. Both audiocassettes are pulsed with audible tones. These tones are cues that the slide projector should be advanced immediately to the next slide.

## Equipment and Materials

Presentation of the module by an instructor to a group of participants requires the equipment and materials listed below:

For the instructor:

- One copy of the Instructor Guide
- A flipchart easel, pad and markers, or chalkboard and chalk
- One copy of the slide/tape program (slides and audiocassettes)
- One slide projector and white projection screen
- One audiocassette player

For the participants:

- A copy of the Participant Manual for each participant
- Paper and pencils for each participant

## Instructor Preparation

The "Demand Forecasting" module is not a self-instructional program. It requires an instructor who is knowledgeable about demand forecasting methods and applications.

Instructor preparation involves a review of the Instructor Guide to become familiar with the topics, the sequence of activities and the content of the presentations. It is also useful to preview the slide/tape program in order to become familiar with the content and the synchronization of the slides with the audiocassettes. If possible, the program should be previewed on the equipment that will be used during the actual presentation.

## Equipment and Facilities Preparation

Preparation of the audiocassettes for play requires rewinding them completely to the beginning. When the cassettes are loaded into the player, Side 1 should show at the top.

Preparation of the carousel trays of slides for viewing requires four steps. First, it is important to ensure that all of the slides are inserted into the tray in sequential order, with the printed numbers showing at the top right corner, along the outer edge of the carousel tray. Second, the black plastic lock ring must be turned in the direction of the arrow marked "Lock" until the ring is secured on the tray. Third, the tray is placed in the operating position by lowering it onto the the projector and turning it clockwise until the tray drops down securely. Fourth, the projector must be advanced so the first slide, the title slide, appears on the screen.

Operation of the slide projector and audiocassette player should be checked prior to the presentation. At that time, it is advisable to arrange for power cords required to operate the projector and the cassette player, extension cords and extra projector bulbs. It is also useful to determine who should be contacted if assistance is needed from an engineer or audiovisual specialist.

It is important to check that each participant will be able to see and hear the slide/tape program easily. To view the slides clearly, overhead and back lighting should be kept to a minimum.

## INSTRUCTOR NOTES

### Overview

The "Demand Forecasting" module includes an overview of the characteristics of demand, the determinants of demand, and forecasting methods.

The module is divided into four parts. Each part includes one segment of the slide/tape program and at least one application activity to reinforce important concepts.

Most of the activities are conducted best in small groups of five to seven participants. If the participants are not divided into small groups, you may want to do so before proceeding with the module.

### Introduction

Time required: 15 minutes

1. Refer the participants to the Introduction on page 1 in their manuals. Review the purpose of the module and the topic outline with them.

2. Ask the participants to describe their past experience with demand forecasting in project selection or planning. Then ask them to describe their objectives in learning about demand forecasting and how they intend to use the information. Knowing about their experience and their objectives will help you relate the content of the module to their needs.

3. Tell the participants that they will not have to take extensive notes during the slide/tape program. Their manuals include copies of the visuals and the narration text from the slide/tape program as well as summaries of all major concepts presented.

4. Introduce Part I of the slide tape program and inform the participants that it is the first of four parts. Explain that Part I includes an overview of the module and a review of the characteristics of demand. Part I of the slide/tape program is approximately ten minutes in length.

5. Turn on the equipment and make sure the title slide is projected before you turn on the audiocassette player. When you turn on the audiocassette player, the music at the start of the program will begin. When you hear the first tone, advance the slide projector immediately to the next slide. Continue advancing the slides at the sound of the tone until the narrator announces the end of Part I and you see a corresponding message projected on the screen.

# Introduction

The "Demand Forecasting" module has been designed for individuals who have a role in project planning or selection and who need a general orientation to the techniques of demand forecasting.

The module includes a review of the topics that are listed below.

INSTRUCTOR NOTES

## PART I: CHARACTERISTICS OF DEMAND

**Review of the Characteristics of Demand** Time required: 15 minutes

1. After the participants have viewed the first part of the slide/tape program, ask them if they have any questions about the content.

2. Ask the participants to turn to page 2 and review the summary information on pages 2, 3 and 4.

# PART I: CHARACTERISTICS OF DEMAND

## Review of the Characteristics of Demand

### Types of Demand

Water consumed is categorized according to the type of activity for which it is used. As a result, in most communities, there are four types of demand, including:

- Domestic demand for water at home;
- Commercial demand for service-oriented areas;
- Industrial demand for treated water; and
- Public sector demand for water for hospitals and schools.

### Measurement of Consumption

Consumption of water by a community is usually expressed as:

- Average daily demand - the result when total annual consumption is divided by the 365 days of the year.

There are two variations to average daily demand:

- Maximum daily demand - the consumption level on the day of the year when consumption is the highest; and
- Peak hour demand - the consumption level during the hour(s) of the day when consumption is the highest

When average daily demand is set at 100%, maximum daily demand is approximately 120% of average daily demand. Peak hour demand is approximately 180% of average daily demand.

**Review of the Characteristics of Demand**
(continued)

## Review of the Characteristics of Demand
(continued)

The table below lists the average and maximum daily demand for several representative cities.

| City | Population in Thousands (December 1969) | Water Consumption from Municipal Water Supply (in liters per capita per day) | | Maximum Demand as a % of Average Daily Demand |
|---|---|---|---|---|
| | | Average | Maximum | |
| Montreal, Canada | 1,460 | 650 | 910 | 141% |
| Los Angeles, U.S.A. | 2,960 | 620 | 980 | 159% |
| Tokyo, Japan | 8,980 | 470 | 560 | 118% |
| Brussels, Belgium | 1,280 | 140 | 160 | 111% |
| Amsterdam, Holland | 830 | 200 | 260 | 134% |
| Stuttgart, West Germany | 620 | 220 | 340 | 151% |
| Oslo, Norway | 490 | 610 | 760 | 126% |
| Stockholm, Sweden | 760 | 450 | 610 | 136% |
| London, England | 6,060 | 290 | 350 | 124% |
| Paris, France | 2,580 | 320 | 400 | 127% |
| Nairobi, Kenya | 700 | 105 | 118 | 113% |

### Unaccounted Water

It is also important to take into account the difference between the amount of water produced and the amount that is consumed. The difference between the two is termed unaccounted water. Usually unaccounted water is expressed as a percentage of the amount of water produced. In order to calculate unaccounted water, two steps are required:

1. Subtract consumption from production.
2. Divide the remainder by production.

An efficient water supply system is one where unaccounted water is 20% or less. In order to forecast supply, it is necessary to add an amount for unaccounted water to consumption forecasts. For example, if Q represents consumption, water production will have to equal 3 Q if unaccounted water is 67%. When unaccounted water is 50%, the level of production will have to be 2Q, and so on.

**Review of the Characteristics of Demand**
(continued)

4. After you complete the review, ask the participants to turn to page 5.

## Review of the Characteristics of Demand
(continued)

### Distribution of Demand

Metering data is a source of information for compiling statistics on the distribution of consumption in a community. In the example below, the community's house connections are divided into increments of 10%, or deciles. Each decile is shown with its share of consumption.

| Share of Consumers | | Share of Consumption | |
|---|---|---|---|
| The first | 10% | Consume | 3% |
| The second | 10% | Consume | 3% |
| The third | 10% | Consume | 3% |
| The fourth | 10% | Consume | 4% |
| The fifth | 10% | Consume | 4% |
| The sixth | 10% | Consume | 5% |
| The seventh | 10% | Consume | 8% |
| The eighth | 10% | Consume | 13% |
| The ninth | 10% | Consume | 20% |
| The tenth | 10% | Consume | 35% |

**Calculating the Distribution of Consumption** Time required: 40 minutes

1. Tell the participants that the next activity will provide them with an opportunity to calculate the distribution of consumption in a community.

2. Review the information and instructions with the participants.

3. Ask them to work with the members of their group to calculate the percentages and to record them in the space provided on page 5. Then instruct them to plot the data on the graph on page 6.

4. After 30 minutes, ask a representative of one group to present the group's calculations. Ask the other groups to review the numbers and to correct any, if necessary. The correct calculations are shown below. (The correct graph is on the following Instructor Notes page.)

| Consumer Group | Number of Consumers | % of Consumers | Cumulative % of Consumers | Volume Consumed | % of Volume | Cumulative % of Volume |
|---|---|---|---|---|---|---|
| 0 - 5 | 1,060 | 5.8 | 5.8 | 2,300 | 0.3 | 0.3 |
| 5 - 7 | 670 | 3.6 | 9.4 | 4,900 | 0.6 | 0.9 |
| 7 - 9 | 920 | 5.0 | 14.4 | 9,200 | 1.2 | 2.1 |
| 9 - 11 | 1,700 | 9.3 | 23.7 | 21,900 | 2.9 | 5.0 |
| 11- 13 | 1,340 | 7.3 | 31.0 | 21,000 | 2.7 | 7.7 |
| 13- 15 | 1,380 | 7.5 | 38.5 | 24,500 | 3.2 | 10.9 |
| 15- 20 | 3,550 | 19.5 | 58.0 | 83,300 | 11.0 | 21.9 |
| 20- 30 | 3,680 | 20.1 | 78.1 | 121,200 | 15.9 | 37.8 |
| 30- 40 | 1,550 | 8.5 | 86.6 | 79,300 | 10.4 | 48.2 |
| 40- 60 | 1,360 | 7.4 | 94.0 | 88,200 | 11.6 | 59.8 |
| 60- 90 | 560 | 3.1 | 97.1 | 53,500 | 7.0 | 66.8 |
| 90- 150 | 260 | 1.4 | 98.5 | 38,500 | 5.0 | 71.8 |
| 150-210 | 90 | 0.5 | 99.0 | 22,000 | 2.9 | 74.7 |
| 210-300 | 60 | 0.3 | 99.3 | 20,600 | 2.7 | 77.4 |
| 300-600 | 80 | 0.5 | 99.8 | 46,000 | 6.0 | 83.4 |
| 600-900 | 20 | 0.1 | 99.9 | 18,700 | 2.4 | 85.8 |
| 900 + | 20 | 0.1 | 100.0 | 108,400 | 14.2 | 100.0 |
| TOTAL | 18,300 | 100.0% | 100.0% | 763,500 | 100.0% | 100.0% |

## Calculating the Distribution of Consumption

In this activity, you will calculate the distribution of consumption in a community. The community's consumers are divided into groups according to their consumption in cubic meters per month.

First, work with the members of your group to calculate the total number of consumers. Record the total at the bottom of the column titled "Number of Consumers."

Second, calculate the percentage of consumers in each group by dividing the number of consumers in each group by the total number of consumers. Record those percentages in the column titled "Percentage of Consumers."

Third, calculate the cumulative distribution of consumers by adding the percentage consumption of each group to the cumulative percentage of the groups that preceed it. Record the cumulative percentages in the column titled "Cumulative Percentage of Consumers."

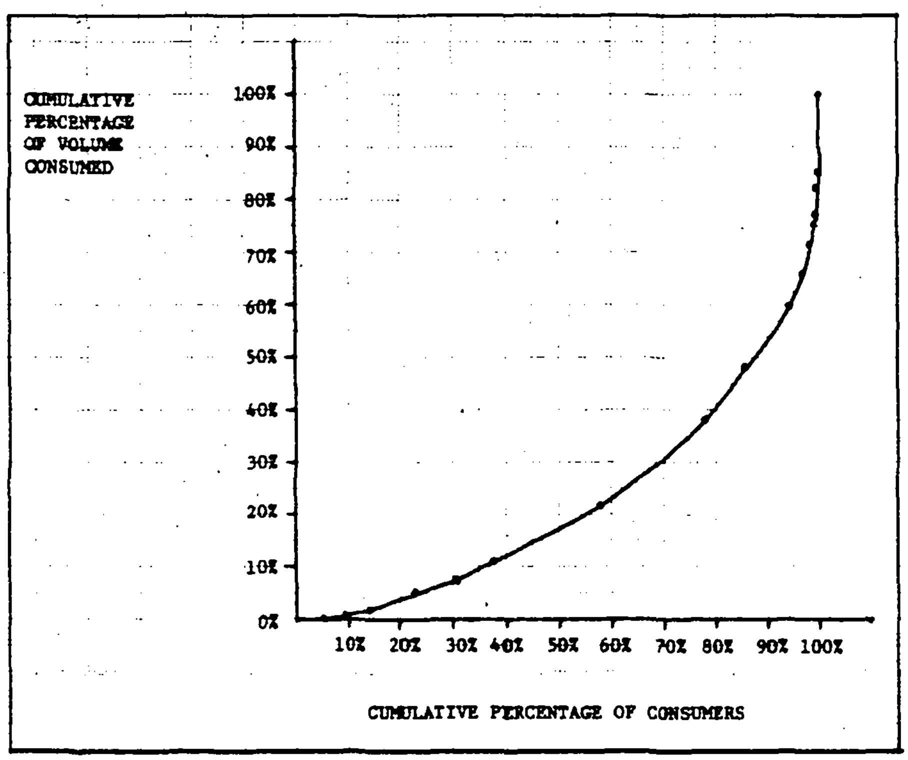
Fourth, calculate the total volume and record that number at the bottom of the column titled "Volume Consumed."

Fifth, calculate the percentage of volume consumed by each group and the cumulative percentage volume consumed. Record the percentages under the columns "Percentage of Volume" and "Cumulative Percentage of Volume."

| Consumer Group | Number of Consumers | % of Consumers | Cumulative % of Consumers | Volume Consumed | % of Volume | Cumulative % of Volume |
|---|---|---|---|---|---|---|
| 0 - 5 | 1,060 | | | 2,300 | | |
| 5 - 7 | 670 | | | 4,900 | | |
| 7 - 9 | 920 | | | 9,200 | | |
| 9 - 11 | 1,700 | | | 21,900 | | |
| 11 - 13 | 1,340 | | | 21,000 | | |
| 13 - 15 | 1,380 | | | 24,500 | | |
| 15 - 20 | 3,550 | | | 83,300 | | |
| 20 - 30 | 3,680 | | | 121,200 | | |
| 30 - 40 | 1,550 | | | 79,300 | | |
| 40 - 60 | 1,360 | | | 88,200 | | |
| 60 - 90 | 560 | | | 53,500 | | |
| 90 -150 | 260 | | | 38,500 | | |
| 150-210 | 90 | | | 22,000 | | |
| 210-300 | 60 | | | 20,600 | | |
| 300-600 | 80 | | | 46,000 | | |
| 600-900 | 20 | | | 18,700 | | |
| 900 + | 20 | | | 108,400 | | |
| TOTAL | ________ | 100.0% | 100.0% | ________ | 100.0% | 100.0% |

**Calculating the Distribution of Consumption**
(continued)

5. Review the correct graph, shown below, with the participants.

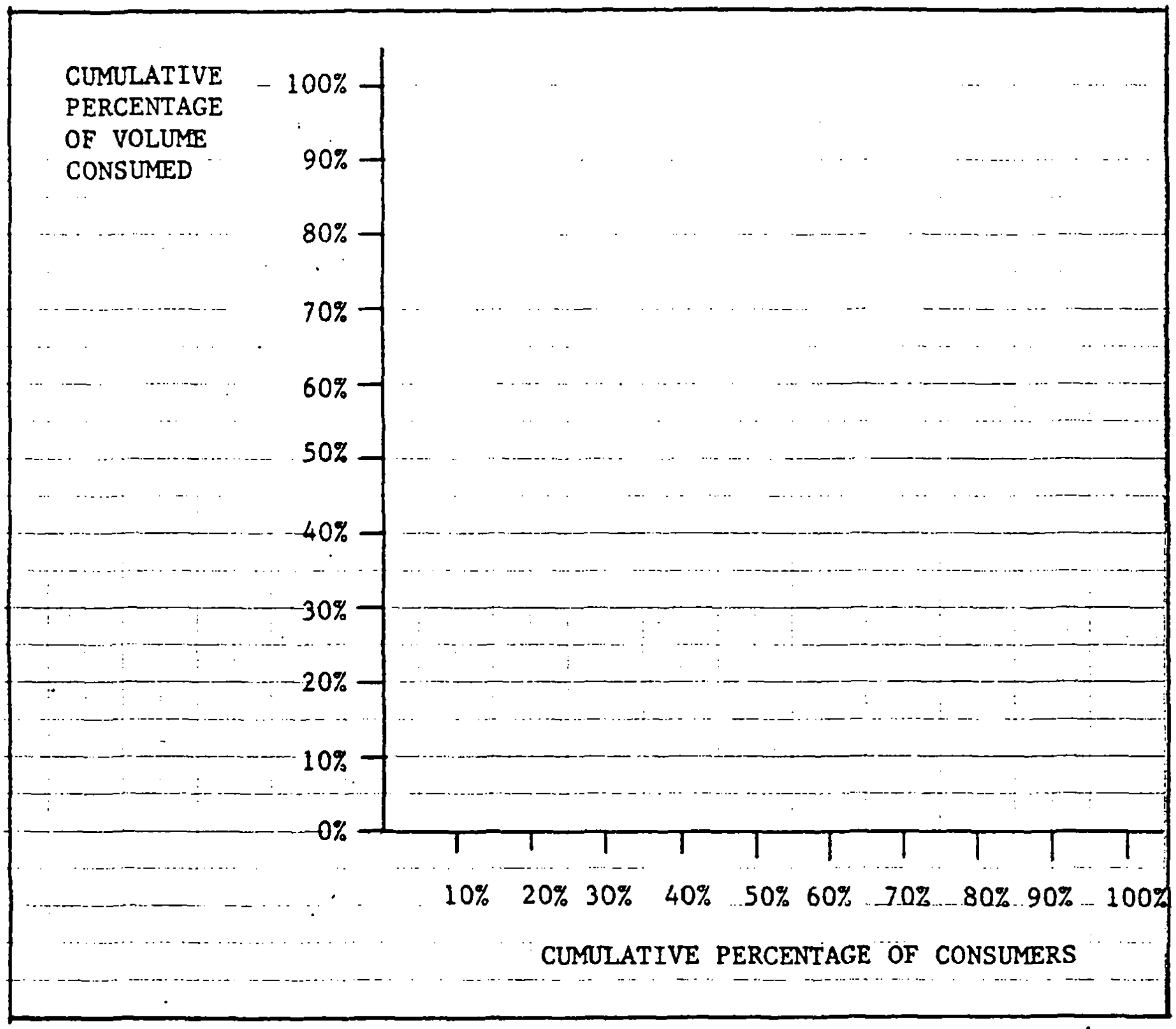



6. Assist the participants to identify ways that they can use statistical data on the distribution of consumption for the projects with which they work.

7. Introduce Part II of the slide/tape program and tell the participants that it includes a review of the determinants of demand. Turn on the projector and make sure the title slide announcing Part II is projected. When you turn on the audiocassette player you will hear a signal tone and the music will begin. When you hear the next signal tone, advance the projector to the next slide. Continue advancing the projector at the sound of the tone until the narrator announces the end of Part II and you see a corresponding message projected on the screen. Part II is approximately eight minutes in length.

## Calculating the Distribution of Consumption
(continued)

Plot the distribution figures that you calculated on page 5 on the graph below.



INSTRUCTOR NOTES

## PART II: DETERMINANTS OF DEMAND: PRICE AND METERING

**Review of Price** Time required: 20 minutes

1. After the participants view the second part of the slide/tape program, ask them if they have any questions.
2. Review the summary information on pages 7 through 9 with the participants.

## PART II: DETERMINANTS OF DEMAND: PRICE AND METERING

### Review of Price

When consumption is metered, the price of water influences consumption. The price that consumers will pay for water reflects their perception of the benefits that they receive from that water. Consumers will pay a high price for water that they believe provides them with high benefits; conversely, they will pay less for water that provides them with less benefits. The price of water is equal to the tariffs that are charged for it. Price is usually expressed as an average tariff per cubic meter of water consumed.

### Price Elasticity

Price elasticity is the indicator used to measure how much demand will change if tariffs increase or decrease.

The calculation of price elasticity requires three steps. In the calculations, Q represents the quantity consumed and P represents price.

$P_0$ is the original price; $P_1$ is the changed price.

$Q_0$ is the original quantity consumed; $Q_1$ is the changed quantity consumed.

1. The first step is to calculate the average price and average quantity, as shown in the equation below.

$$\frac{Q_0 + Q_1}{2} = \text{Average Quantity Consumed} \qquad \frac{P_0 + P_1}{2} = \text{Average Price}$$

2. The second step is to calculate the absolute changes in both quantity consumed and the price paid. The calculation of absolute changes is shown in the equation below.

$$Q_0 - Q_1 = \text{Absolute Change in Quantity} \qquad P_0 - P_1 = \text{Absolute Change in Price}$$

**Review of Price**
(continued)

Then, the relative change is calculated by dividing the absolute changes by the average. The second step, therefore, is summarized in the equation shown below:

$$\frac{Q_0 - Q_1}{\frac{Q_0 + Q_1}{2}} = \text{Relative Change in Quantity} \qquad \frac{P_0 - P_1}{\frac{P_0 + P_1}{2}} = \text{Relative Change in Price}$$

3. The third step is to calculate the price elasticity by dividing the relative change in quantity by the relative change in price. That calculation is shown in the equation below.

$$\frac{\dfrac{Q_0 - Q_1}{\frac{Q_0 + Q_1}{2}}}{\dfrac{P_0 - P_1}{\frac{P_0 + P_1}{2}}} = \text{Price Elasticity}$$

Studies show that, in the short-term, price elasticity of water demand is approximately -0.3. This means that consumption will decrease an average of 30% if the tariff increases by 100%. Long-term elasticity averages -0.6. The price elasticity is lower for low-income consumers and higher for high-income users. Evidence for the price-sensitivity of water demand is provided in a variety of studies conducted all over the world. The chart on the next page summarizes some of the results of those studies.

**Review of Price**
(continued)

3. After you conclude the review, tell the participants to turn to page 10.

EVIDENCE OF PRICE ELASTICITY OF WATER DEMAND

| Location/Year | Calculated Average Elasticity | Tariff Increase | Average Monthly Consumption per Connection | Number of Connections | Observations |
|---|---|---|---|---|---|
| Bogota, Colombia 1972/73 | -0.44 | 6% | $50m^3$ | 270,000 | Carefully metered system with good water supply. Elasticity short-run as time series analysis applied. |
| Bogota, Colombia 1974/75 | -0.12 | 13% | $48m^3$ | 310,000 | Ditto |
| Cartagena, Colombia 1973/74 | -0.33 | 55% | $50m^3$ | 25,000 | Data reliability rather good but water services rationed in parts. Elasticity is short-run. |
| Manizales, Colombia 1972/73 | -0.60 | 80% | $60m^3$ | 24,000 | Data reliability good. |
| Manizales, Colombia 1974/75 | -0.18 | 41% | $42m^3$ | 25,000 | Ditto |
| Medellin, Colombia 1973 | -0.17 | N.A. | N.A. | 150,000 | Ditto |
| 41 Selected U.S. Areas, 1966 | -0.23 | N.A. | N.A. | N.A. | Cross-sectional study implying long-run elasticity. |
| Toronto, Canada 1972 | -0.93 | N.A. | N.A. | N.A. | Cross-sectional study implying long-run elasticity. |
| 13 Communities, Georgia, U.S.A., 1967 | -0.67 | N.A. | N.A. | N.A. | Cross-sectional study implying long-run elasticity. |
| Penang Island, Malaysia | -0.15 | N.A. | N.A. | N.A. | Time-series analysis implying short-run elasticity. |
| 43 Systems in Utah, U.S.A. 1964 | -0.77 | N.A. | N.A. | N.A. | Cross-sectional study implying long-run elasticity. |
| One Standard Metropolitan Area, U.S.A. | -0.63 | N.A. | N.A. | N.A. | Cross-sectional study implying long-run elasticity. |
| 38 Cities in Africa, Asia and Latin America | -0.43 | N.A. | N.A. | N.A. | Poor data reliability. Cross-sectional analysis implying long-run elasticity. |
| Yuma, Arizona, U.S.A. | -0.22 | 45% | N.A. | N.A. | Time-service analysis implying short-term elasticity. |
| Yuma, Arizona, U.S.A. | -0.33 | 48% | N.A. | N.A. | Time-series analysis implying short-term elasticity. |
| Kansas City, Mo., U.S.A. | -0.20 | 50% | N.A. | N.A. | Ditto |
| New Orleans, La., U.S.A. | -.09 | 70% | N.A. | N.A. | Ditto |
| Average Unweighted Short-term Elasticity | **-0.3** | | | | |
| Average Adjusted Long-run Elasticity | **-0.6** | | | | |

INSTRUCTOR NOTES

**Calculation of Price Elasticity** Time required: 20 minutes

1. Explain that the next activity will give the participants some experience in calculating price elasticity.

2. Review the instructions and information on page 10 with the participants. Then instruct them to work with the members of their group to calculate the short-term price elasticity indicated by the tariff increase.

3. After 15 minutes, stop the participants. Ask a representative of one group to present the group's calculations. Ask the other groups to review the calculations and to correct them if necessary. The correct calculations are shown below.

$$\frac{\dfrac{Q_0 - Q_1}{\dfrac{Q_0 + Q_1}{2}}}{\dfrac{P_0 - P_1}{\dfrac{P_0 + P_1}{2}}} = \frac{\dfrac{50 - 43}{\dfrac{50 + 43}{2}}}{\dfrac{7 - 11}{\dfrac{7 + 11}{2}}} = \frac{.15}{-.44} = -0.34$$

4. Assist the participants to identify ways that they can apply price elasticity data to the projects with which they work.

5. Conclude the activity and direct the participants to the next page.

## Calculation of Price Elasticity

In this activity you will calculate the price elasticity for a community that raises the tariff for water.

In this case, the community raised the tariff from 7 to 11 pesos per cubic meter. Average consumption per connection then decreased from 50 to 43 cubic meters per month.

Work with the members of your group to calculate the short-term price elasticity of demand for water. The equation for calculating price elasticity is shown below.

$$\frac{\dfrac{Q_0 - Q_1}{\dfrac{Q_0 + Q_1}{2}}}{\dfrac{P_0 - P_1}{\dfrac{P_0 + P_1}{2}}} = \text{Price Elasticity}$$

INSTRUCTOR NOTES

**Review of Metering** Time required: 10 minutes

1. Ask the participants to turn to page 11. Review the information on pages 11 and 12 with them.

## Review of Metering

Wherever sewerage is available, only metering can hold water consumption within reasonable proportions. Several studies have proved that the installation of meters can reduce water consumption significantly. This, in turn, will reduce the wastewaters produced.

For example, a large study conducted in 1967 in the Netherlands included a cross-sectional analysis of towns and cities with a population of over 50,000 inhabitants. The study showed that per capita consumption levels were 40% lower in metered systems. The relation did not hold true for communally-metered supplies where consumers did not feel any individual responsibility for reducing consumption. The 40% decrease in consumption with metering is also supported by the other studies that are summarized in the list below.

### Effect of Metering on Consumption

| | |
|---|---|
| Punjab, India | For the socio-economically very similar cities Ludhiana and Jullundur, average monthly production excluding 40% water unaccounted-for was found to be 45 $m^3$ for Ludhiana which is well metered, and 69 $m^3$ for Jullundur which is practically unmetered. Extensive metering in Jullundur could be expected, ceteris paribus, to result in a drop of 33% in water consumed per connection. |
| Pueblo, Colorado | Metered residential consumers were consuming at rates 60% of those in unmetered areas. The introduction of metering could be expected to result, ceteris paribus, in a drop of 40% in water consumed by unmetered consumers. |
| Boulder, Colorado | The introduction of metering reduced residential demand by 36%. |
| Lima, Peru | Overall consumption dropped 30% when metering was increased from 44% to 100% of those connected. |

**Review of Metering**
(Continued)

2. After you conclude your review, ask the participants to turn to page 13.

**Review of Metering**
(continued)

| | |
|---|---|
| Bogota, Colombia | Overall consumption dropped 54% when meter coverage grew from 8% to 68%. |
| Cali, Colombia | Overall consumption dropped 44% when meters were introduced on 80% of the service connections. |
| Honiara, British Solomon Islands | Overall consumption dropped 43% over a year's time when metering was introduced for 100% of the connections. |
| Average reduction after extensive metering | 40% |

INSTRUCTOR NOTES

**Effects of Metering** Time required: 20 minutes

1. Explain that the next activity will give the participants some experience in calculating the effects of metering on decreasing demand and, therefore, decreasing the need for capacity expansion.

2. Review the instructions and information on page 13 with the participants. Then instruct them to work with the members of their group to calculate the number of years that capacity expansion could be postponed if 100% of connections were metered.

3. After 10 minutes, stop the participants. Ask a representative of one group to present the group's calculations. Ask the other groups to review the calculations and to correct them if necessary. The correct calculations are shown below.

   Consumption per connection is expected to decrease from 70 cubic meters to 42 cubic meters:

   $$.60 \cdot 70\text{m}^3 = 42\text{m}^3$$

   The next step is to solve for x, a year, in the equation:

   $$42\text{m}^3 \cdot 1.06^x = 70\text{ m}^3$$

   Therefore, $1.06^x = \frac{70}{42} = 1.66$

   The calculations are: $1.06^8 = 1.59$, $1.06^9 = 1.69$ = 1.66 is reached between years 8 and 9

   A capacity expansion can be postponed approximately 8 1/2 years if connections are metered and consumption decreases 40%.

4. Conclude the activity and introduce Part III of the slide/tape program. Explain that it includes a review of two more determinants of demand: income and service levels. Project the title slide before you turn on the audiocassette player. When you turn on the audiocassette player, the music will begin. Then, when you hear the first signal tone, advance the projector at the sound of the tone until the narrator announces the end of Part III and you see a corresponding message projected on the screen. Part III is approximately eight minutes in length.

## Effects of Metering

In this activity you will calculate the effects of metering on decreasing demand and, therefore, postponing the need to expand a current system's capacity.

A community's present consumption is 70 cubic meters per month for unmetered connections. The consumption for these connections is increasing at 6% per year. The community intends to meter 100% of all connections within one year.

Studies indicate that the expected reduction in consumption would be about 40%.

Work with the members of your group to calculate how many years a capacity expansion could be delayed if consumption per metered connection decreased 40%.

INSTRUCTOR NOTES

## PART III: DETERMINANTS OF DEMAND: INCOME AND SERVICE LEVELS

**Review of Income and Service Levels** Time required: 15 minutes

1. After the participants have viewed the third part of the slide/tape program, ask them if they have any questions.

2. Review the summary information on pages 14 and 15 with the participants.

## PART III: DETERMINANTS OF DEMAND: INCOME AND SERVICE LEVELS

### Review of Income and Service Levels

#### Income

Income levels influence consumption. As a rule, consumption increases with higher income.

Income elasticity is calculated by dividing the relative increase in consumption by the relative income growth.

Studies have shown income elasticity to average 0.3; however, income data are difficult to estimate accurately and 0.3 income elasticity may not hold over very large income intervals.

Four studies conducted in various parts of the world are useful in showing the relative income elasticity of water demand.

| Area | Calculated Elasticity | Observations |
|---|---|---|
| 38 cities in Africa, Asia and Latin America | + 0.33 | Poor data reliability; Cross-sectional analysis indicating long-term elasticity |
| Penang Island, Malaysia | from 0 to + 0.4 | Cross-sectional analysis of 1,400 households indicating long-term elasticity |
| 13 communities in the state of Georgia, U.S.A. | + 0.33 | Cross-sectional analysis indicating long-term elasticity |
| Selected areas in the U.S.A. | + 0.32 | Cross-sectional analysis indicating long-term elasticity |
| Unweighted Average Long-Term Income Elasticity | + 0.3 | |

**Review of Income and Service Levels**
(continued)

3. After you conclude the review, tell the participants to turn to page 16.

## Service Levels

The service levels that are available to consumers will influence the demand for water. Consumers who rely upon community standposts consume an average of 20 liters per capita per day because it is inconvenient for them to transport more than that amount. Households with yard connections consume between 50 and 100 liters per capita per day. And, households with house connections or indoor plumbing consume 100 or more liters per capita per day. The data show that consumption increases substantially as service levels improve.

## Other Factors

In addition to price, metering, income and service levels, there are four other determinants that may influence the demand for water in a community. They are:

<u>Drainage</u> - Poor drainage of wastewaters will decrease consumption so that the surrounding soil can absorb the water.

<u>Continuity of Service</u> - If rationing is in effect, consumption may increase as consumers collect water for use during times of interrupted service, and then discard the water when service resumes.

<u>Service Pressure</u> - Water consumption increases when water comes out of the tap at high velocity. Similarly, leakage increases with higher service pressure.

<u>Climate</u> - Water consumption will increase during the hottest and driest seasons of the year. Water consumption will decrease during rainy seasons when water is more abundant.

**Discussion of Determinants of Demand** Time required: 20 minutes

1. Ask the participants to turn to page 16. Instruct them to discuss the questions on determinants of demand with the members of their group.

2. After 15 minutes, stop the participants and ask a representative of one group to summarize the group's conclusions. Ask the other groups to add any points not covered by the first group.

3. When you are ready to proceed, introduce the fourth part of the slide/tape program on forecasting methods. Turn on the projector and make sure the title slide announcing Part IV is projected. When you turn on the audiocassette player, you will hear a signal tone and the music will begin. When you hear the next signal tone, advance the projector to the next slide. Continue advancing the projector at the sound of the tone until the narrator announces the end of the program and you see a corresponding message projected on the screen. Part IV is approximately eleven minutes in length.

## Discussion of Determinants of Demand

Now that you have reviewed the many determinants of demand, apply the information to the communities and projects with which you work.

Discuss the questions below with the members of your group. Focus on the similarities and differences among the communities represented by the members of your group.

- To what extent do the determinants of demand listed below influence the demand for water in your communities? Place a check in the column that corresponds to the level of influence.

| | Influence on Demand: | | |
|---|---|---|---|
| **Determinants** | **Minimal** | **Some** | **Significant** |
| Price | | | |
| Metering | | | |
| Income | | | |
| Service Levels | | | |
| Drainage | | | |
| Continuity of Service | | | |
| Service Pressure | | | |
| Climate | | | |

- What steps have been taken to use any of the determinants to curb demand so that expansion of existing capacity can be postponed? How successful were they? What problems were encountered?

- In recent or future projects in which you are involved, how are any or all of the factors analyzed in order to meet demand without requiring unnecessarily large projects?

INSTRUCTOR NOTES

## PART IV: FORECASTING METHODS

**Review of Forecasting Methods** Time required: 20 minutes

1. After the participants have viewed the fourth part of the slide/tape program, ask them if they have any questions.

2. Review the summary information on pages 17 and 18 with the participants.

## PART IV: FORECASTING METHODS

## Review of Forecasting Methods

### Variables to Include in Forecasts

Regardless of the forecasting method used, it is important to take the following variables into account:

- Amount of water consumed;
- Amount of unaccounted water;
- Amount that must be produced to satisfy consumption plus unaccounted water.

### Timing of Forecasts

It is useful to analyze demand at different points in time.

Short-term forecasts extend up to two years into the future. Medium-term forecasts extend approximately eight years into the future. Long-term forecasts extend up to twenty years into the future. Forecasts that go beyond twenty years are of less value because the margin of error is high and most designs should not extend beyond 20 years.

### Historical Data as the Basis for Forecasts

Forecasting begins with collecting historical data on the following:

- Past consumption levels
- Percentage of unaccounted water
- Total population
- Population served
- Number of house connections
- Expected changes in price of water
- Metering
- Income
- Other determinants

**Review of Forecasting Methods**
(continued)

3. After you conclude the review, tell the participants to turn to page 19.

## Forecasting Methods

Three commonly used forecasting methods are the requirements, exponential and explanatory methods.

- Requirements method - Historical consumption per capita per year is plotted against years, a line is fitted to the plot points and the trend line is extended in order to forecast future consumption. The historical data for served population are plotted against years, a line through the points is drawn and extended in order to forecast future population. The future consumption per capita is multiplied by the future served population to calculate total consumption. Unaccounted water is then forecast by plotting past percentages, drawing a line and forecasting future levels. Last, the production forecast is obtained by the calculation shown below:

$$\text{Production Forecast} = \frac{\text{Consumption Forecast}}{(1 - \%\ \text{Unaccounted Water})}$$

- Exponential method - extrapolates past consumption trends in order to forecast future trends. Historical water consumption is plotted on semilogarithmic paper against the historical years or served population.

**X axis - Historical Years or Served Population**
**Y axis - Historical Water Consumption**

A line is fitted through the points and extended in order to project future consumption. The production forecast is obtained using the equation below:

$$\text{Production Forecast} = \frac{\text{Consumption Forecast}}{(1 - \%\ \text{Unaccounted Water})}$$

- Explanatory method - estimates demand by plotting historical consumption against house connections. The variables are plotted on double logarithmic graph paper.

**X axis - House Connections**
**Y axis - Historical Consumption**

A line is fitted through the points and extended in order to project future consumption. Projected house connections can be based on investment plans and historical house connections. The production forecast is then obtained using the equation below.

$$\text{Production Forecast} = \frac{\text{Consumption Forecast}}{(1 - \%\ \text{Unaccounted Water})}$$

INSTRUCTOR NOTES

**Forecast Preparation: Historical Data** Time required: 10 minutes

1. Explain that the next three activities will give the participants an opportunity to prepare forecasts using the three forecasting methods that they just reviewed.

2. Review the case study information and the instructions on page 19 with the participants. Answer any questions they have about the data or the three forecasts they will prepare.

3. Then direct the participants to page 20.

## Forecast Preparation: Historical Data

In this activity, you will use historical data to project demand using the three forecasting methods. Specifically, you will use data from years 1961 - 1967 to project demand in 1980. You will then analyze the advantages of each method by comparing projected with actual data.

The forecasts will be based on historical data on Bogota, the capital of Colombia. Bogota is the country's largest and most important industrial, commercial, administrative and educational center. It is located at an altitude of 2,600 meters on the western slopes of the Cordillera Oriental of the Andes. Bogota is known for plentiful rainfall (980 mm per year), a cool climate (average temperature of 14° during the year), absence of tropical diseases and ample space for expansion. Another important factor is the availability of abundant and favorably located water resources for water supply and power generation. The chart below provides the historical data you will need for all three forecasting methods.

### HISTORICAL DATA - BOGOTA, COLOMBIA

**WATER CONSUMPTION AND PRODUCTION: 1961 - 1967**

| Year | Consumption by House Connections (in Millions $m^3$ per year) | Production (in Millions $m^3$ per year) | Un-Accounted Water | Number of House Connections | Total Population (Millions) | Population with House Connections |
|---|---|---|---|---|---|---|
| 1961 | 76 | 98 | 23% | 121,000 | 1.39 | 68% |
| 1962 | 78 | 106 | 26% | 127,000 | 1.49 | 67% |
| 1963 | 87 | 115 | 25% | 138,000 | 1.59 | 68% |
| 1964 | 100 | 128 | 21% | 152,000 | 1.70 | 70% |
| 1965 | 96 | 123 | 22% | 161,000 | 1.83 | 69% |
| 1966 | 91 | 127 | 28% | 170,000 | 1.96 | 68% |
| 1967 | 116 | 156 | 26% | 182,000 | 2.09 | 68% |

**Forecast Preparation: Instructions**

1. Point out that the next pages include the graph paper and the calculation space that the participants will need to prepare the forecasts.

2. Review the instructions for preparing each forecast on pages 20, 24 and 27.

3. Explain that the participants will begin with the requirements method. The space they need for calculations is provided on page 21. The graph paper they will need is on pages 22 and 23. Then point out that pages 25 and 26 include the calculation space and graph paper for a forecast using the exponential method. Pages 28, 29 and 30 include the calculation space and graph paper for a forecast using the explanatory method.

4. Tell the participants that they will have 90 minutes to prepare all three forecasts. You will need to call time every 30 minutes so that they can allocate equal time to each forecast. After they complete all three forecasts, bring the groups back together and begin to review each forecast they prepared. The review will require approximately 45 minutes.

5. Record each group's forecasts on the board or flipchart before you supply them with the actual 1980 data.

**Requirements Method** Time required: 30 minutes

1. Before participants begin work on the forecasts, review the instructions on page 20 for forecasting production using the requirements method.

## Forecast Preparation: Requirements Method

It takes six steps to prepare a production forecast using the requirements method.

1. Calculate consumption per capita for each historical year by using the equation shown below.

$$\frac{\text{Historical Consumption}}{\text{Total Population} \times \text{Percentage of Population with House Connections}}$$

2. Plot the data on per capita consumption for each historical year on the graph paper on page 22. Fit a line through the points and extend the line to locate the projected per capita consumption in 1980.

3. Plot the historical data on the served population against historical years on the graph paper on page 22. Fit a line through the points and extend the line in order to project the served population in 1980.

4. Multiply the projected served population in 1980 by the projected consumption per capita in 1980 in order to calculate total consumption in 1980.

5. Project unaccounted water and annual per capita consumption in 1980. Plot the historical data on the graph paper on page 23, draw a line through the points and extend the line to estimate the percentage of unaccounted water and the annual per capita consumption in 1980.

6. Calculate the production forecast for 1980 by using the equation below.

$$\text{Production Forecast} = \frac{\text{Consumption Forecast}}{(1 - \%\ \text{Unaccounted Water})}$$

**Requirements Method**
(continued)

1. After the participants have prepared forecasts using all three methods, bring the group together to review them, beginning with the requirements method.

2. Ask a representative of each group to display the group's 1980 production and consumption forecasts on the board or flipchart. Ask the groups to compare their forecasts and to discuss the reasons for any differences among them.

3. The calculations for the 1980 forecasts are shown below. (Because fitting a free hand line in order to project future data is imprecise, you can expect some variances among the group's calculations.)

**Historical Data**

| Year | Consumption Per Capita Per Year | Served Population |
|---|---|---|
| 1961 | $\frac{76 \text{ MM}}{1.39 \text{ MM} \quad 0.68} = 80 \text{ m}^3$ | .94 MM |
| 1962 | $\frac{78 \text{ MM}}{1.49 \text{ MM} \quad 0.67} = 78 \text{ m}^3$ | 1.00 MM |
| 1963 | $\frac{87 \text{ MM}}{1.59 \text{ MM} \quad 0.68} = 80 \text{ m}^3$ | 1.08 MM |
| 1964 | $\frac{100 \text{ MM}}{1.70 \text{ MM} \quad 0.70} = 84 \text{ m}^3$ | 1.19 MM |
| 1965 | $\frac{96 \text{ MM}}{1.83 \text{ MM} \quad 0.69} = 76 \text{ m}^3$ | 1.26 MM |
| 1966 | $\frac{91 \text{ MM}}{1.96 \text{ MM} \quad 0.68} = 68 \text{ m}^3$ | 1.33 MM |
| 1967 | $\frac{116 \text{ MM}}{2.09 \text{ MM} \quad 0.68} = 82 \text{ m}^3$ | 1.42 MM |

**Projected Data (from graphs)**

1980 Projected Consumption = 4.0 • 79 = 316 $\text{MMm}^3$

Projected Production = $\frac{316}{1-0.24}$ = 416 $\text{MMm}^3$

**Actual Data**

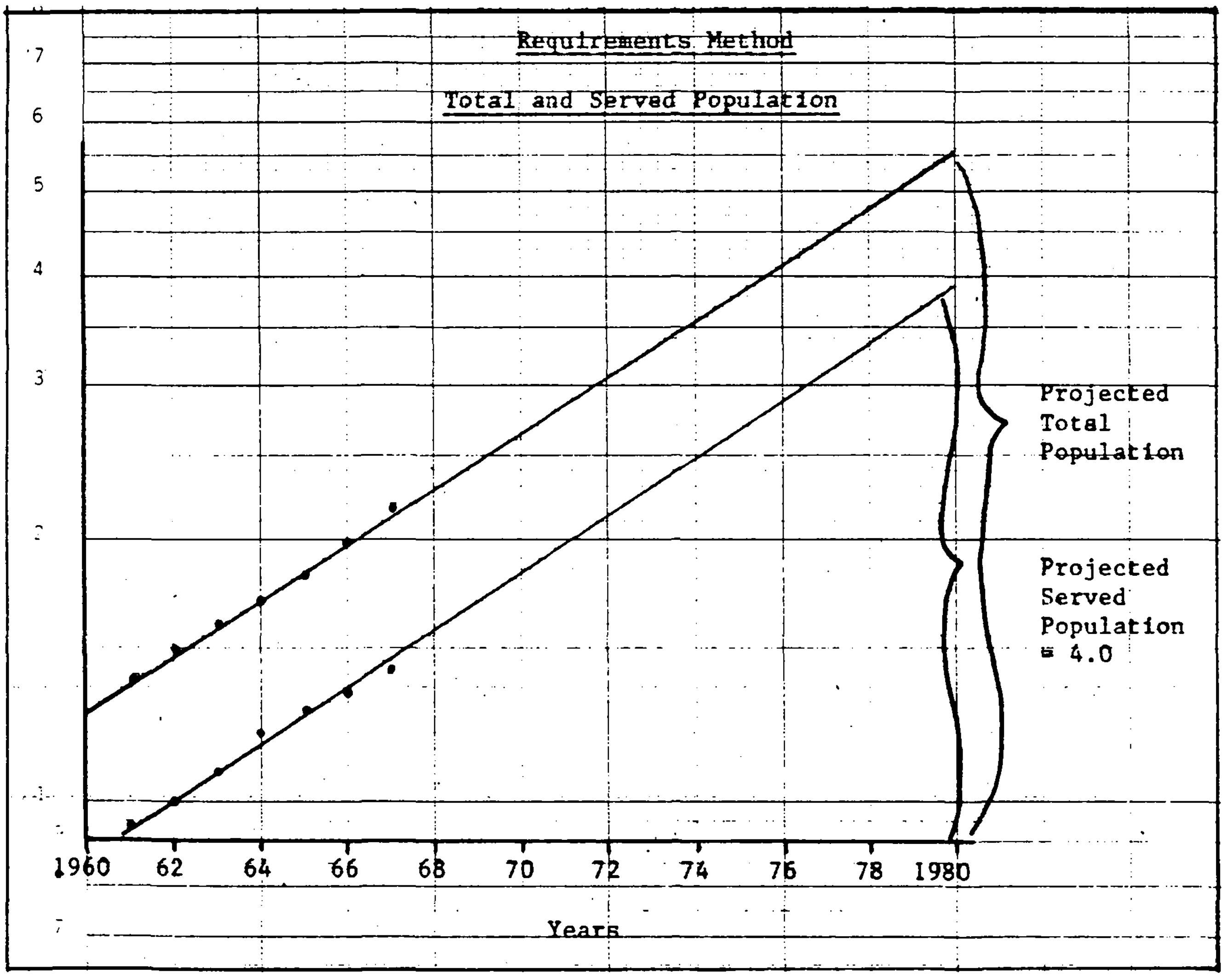
| Year | Consumption by House Connections (in millions $m^3$ per year | Production (in Millions $m^3$ per year) | Un-Accounted Water | Total Population (Millions) | Population with House Connections |
|---|---|---|---|---|---|
| 1980 | 223 | 339 | 34% | 3.95 | 90% |

## Requirements Method
(continued)

Use the space below for your calculations.

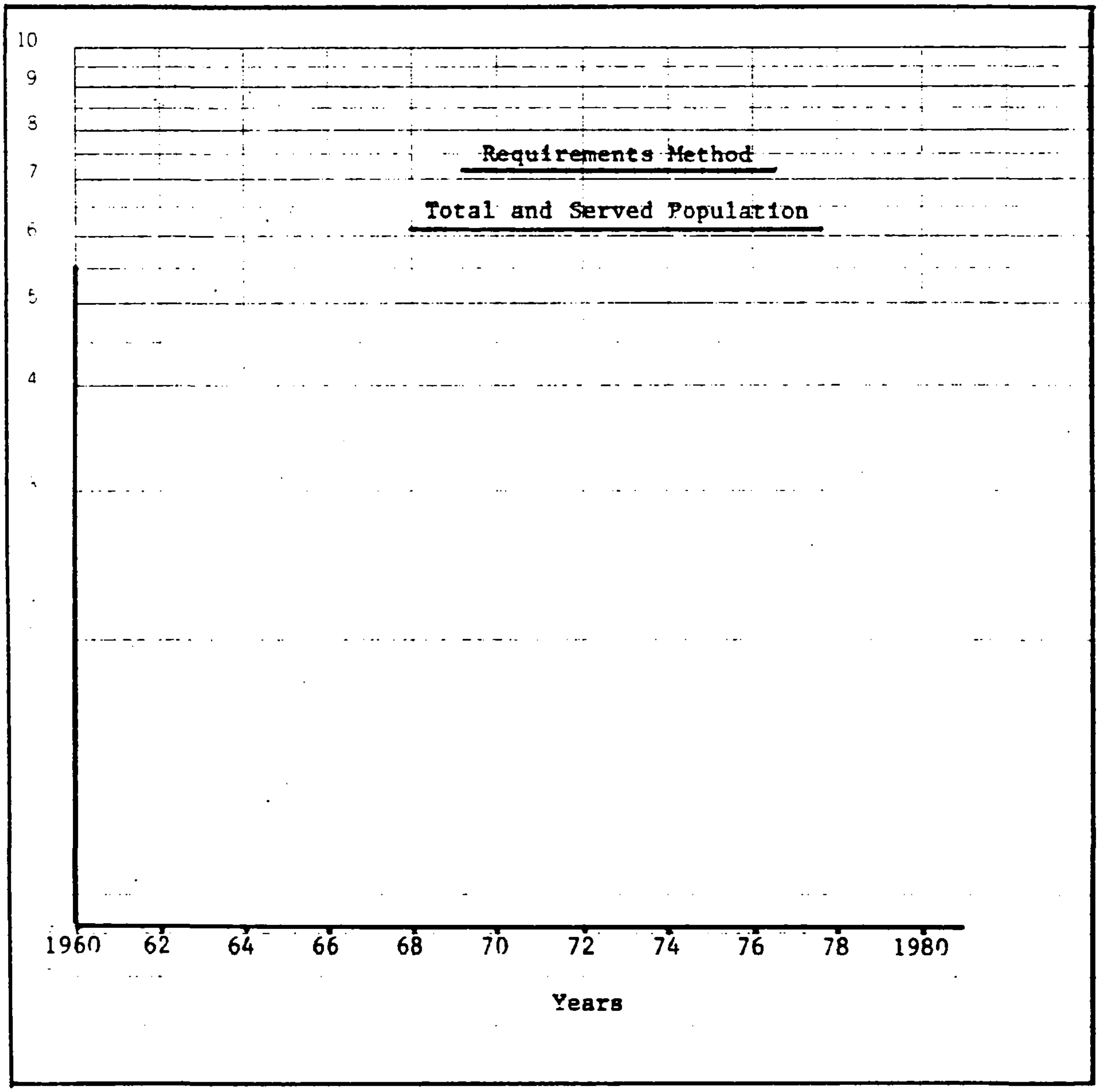
**Requirements Method**
(continued)

4. The graph for projecting total and served population is shown below. (Because fitting a free hand line in order to project data is imprecise, the participants' graphs may vary slightly.)



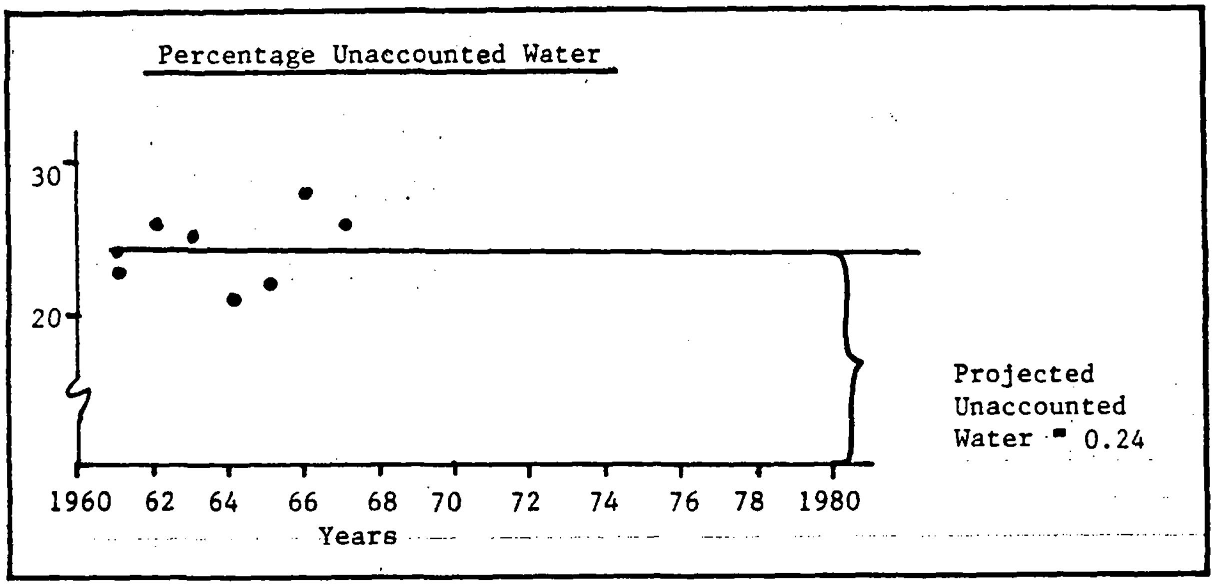
## Requirements Method
(continued)

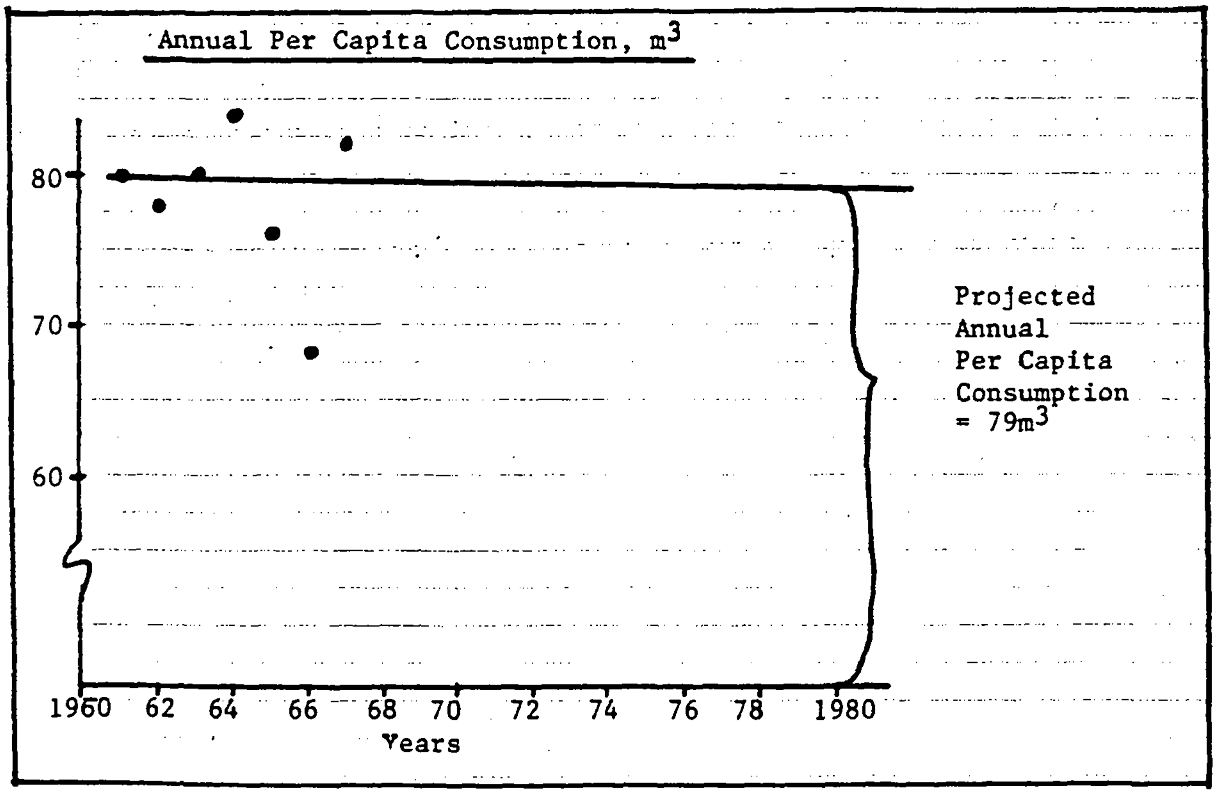
Plot the historical data and project future data for the total and served population on the graph paper below.



**Requirements Method**
(continued)

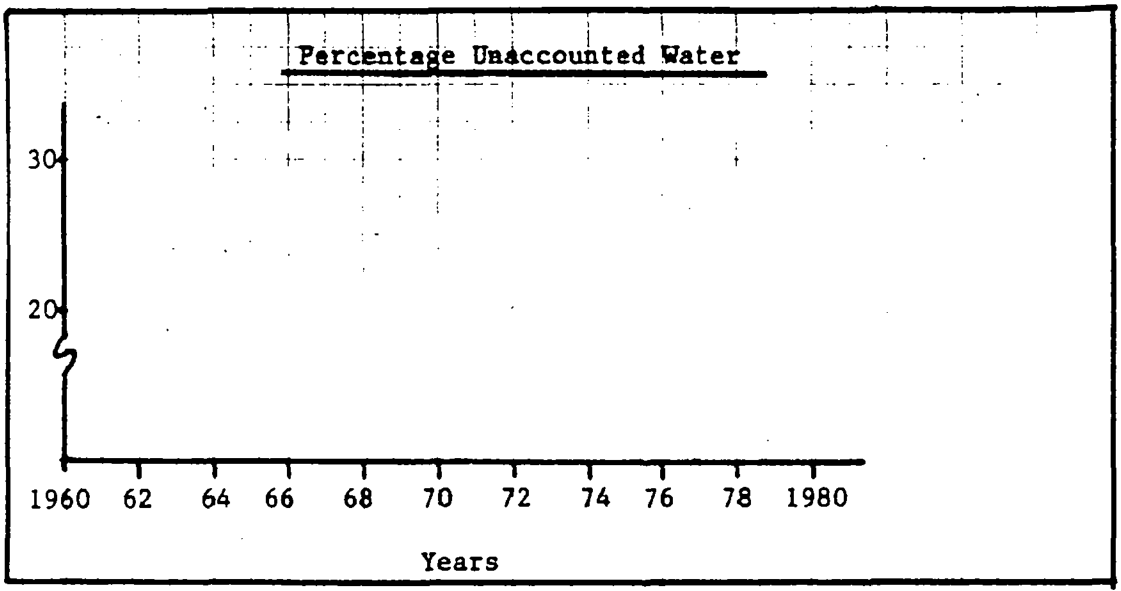
5. The graphs for the projected percentage of unaccounted water and the annual per capita consumption are shown below. (Because fitting a free hand line in order to project data is imprecise, the participants' graphs may vary slightly).

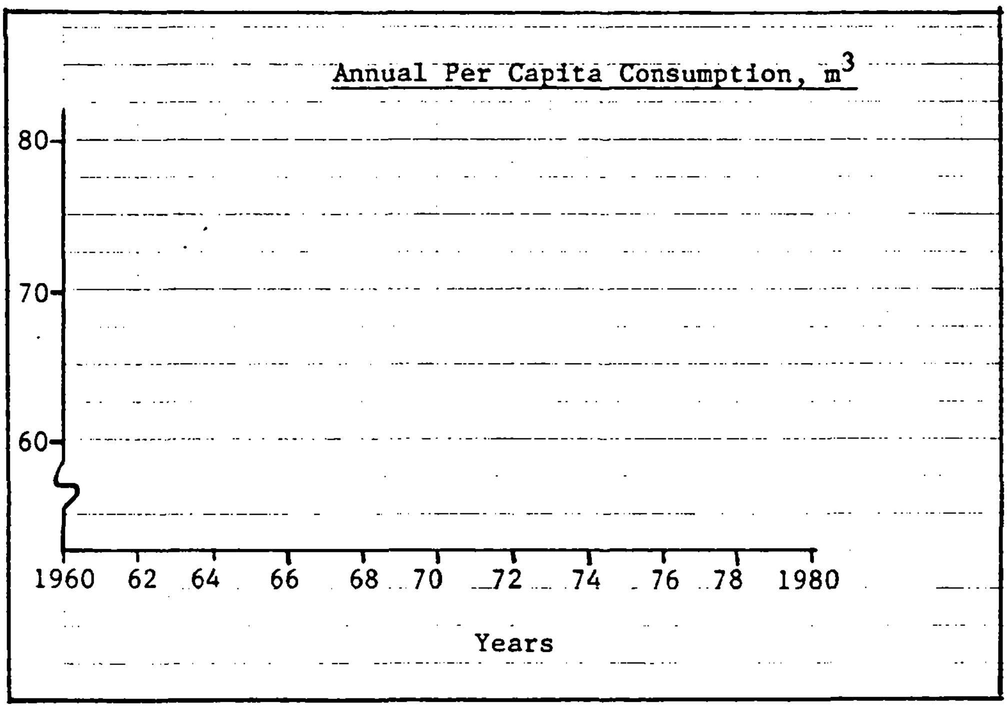


## Requirements Method
(continued)

Plot the historical data and project future data for the percentage of unaccounted water and the annual per capita consumption on the graph paper below.



INSTRUCTOR NOTES

**Exponential Method** Time required: 30 minutes

1. Before participants begin work on the forecasts, review the instructions on page 24 for forecasting production using the exponential method.

## Exponential Method

It takes four steps to prepare a forecast using the exponential method.

1. Plot historical consumption against each historical year or served population on the semilogarithmic graph paper on page 26.

2. Fit a line through the points on the graph paper and extend the line in order to project consumption in 1980.

3. Obtain the projection of unaccounted water in 1980 from the forecast you prepared using the requirements method.

4. Apply the projected consumption and percentage of unaccounted water to the equation below and calculate a final forecast.

$$\text{Production Forecast} = \frac{\text{Consumption Forecast}}{(1 - \%\ \text{Unaccounted Water})}$$

**Exponential Method**
(continued)

1. When you are ready to review the groups' forecasts using the exponential method, ask a representative of each group to display their 1980 forecasts on the board or flipchart. Ask the groups to compare their forecasts and to discuss the reasons for any differences among them.

Projected Data

| 1980 | Consumption from high in Million $m^3$ | Unaccounted Water, % | Production in Million $m^3$ |
|---|---|---|---|
| | 280 | 24% | $\frac{280}{1-0.24} = 368$ |

Actual Data

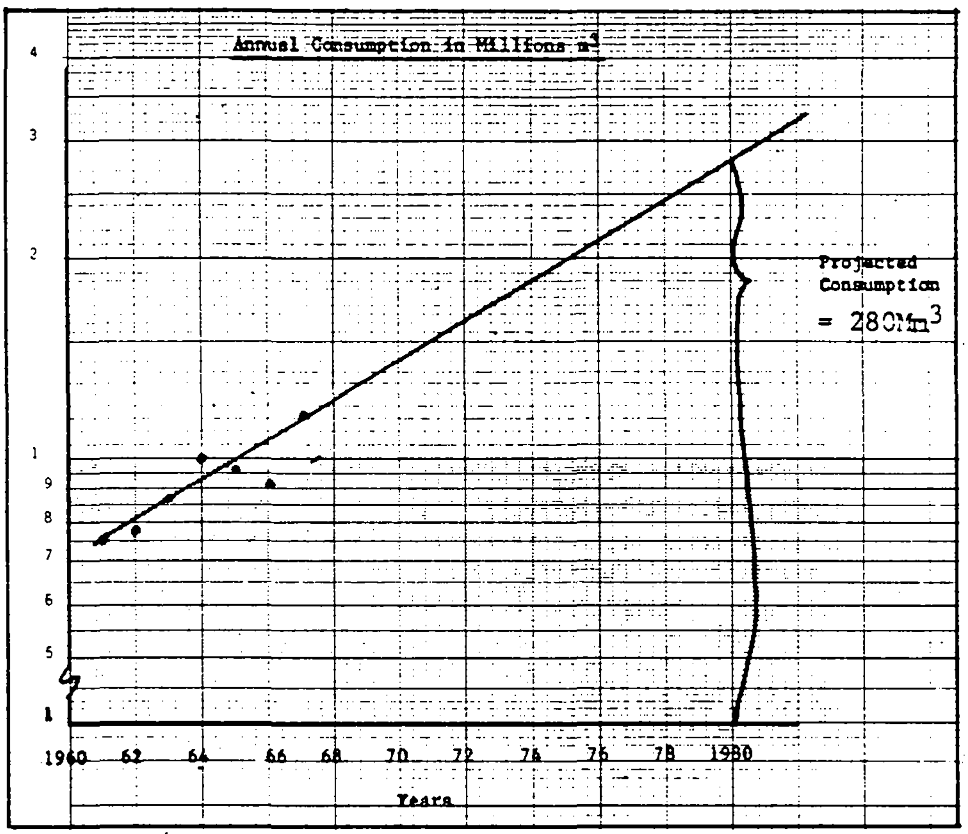
| Year | Consumption by House Connections (in Millions $m^3$ per year | Production (in Millions $m^3$ per year) | Water Un-Accounted For | Total Population (Millions) | Population with House Connections |
|---|---|---|---|---|---|
| 1980 | 223 | 339 | 34% | 3.95 | 90% |

## Exponential Method
(continued)

Use the space below for your calculations.

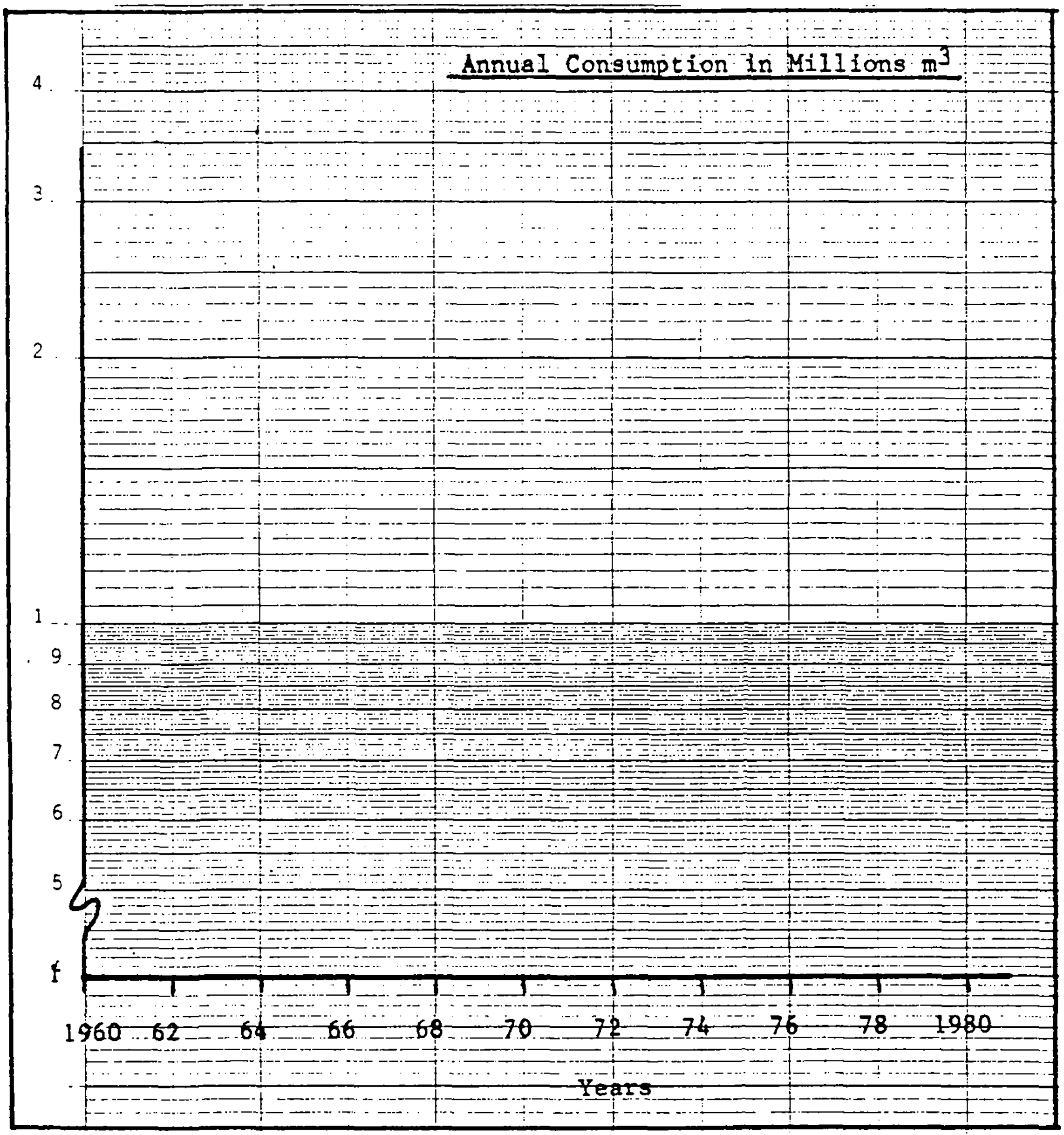
**Exponential Method**
(continued)

2. The graph for the exponential method is shown below. (Because fitting a free hand line in order to project data is imprecise, the participants' graphs may vary slightly.)



**Exponential Method**
(continued)

Plot the historical data and project future data on the graph paper below.



INSTRUCTOR NOTES

**Explanatory Method** Time required: 30 minutes

1. Before participants begin work on the forecasts, review the instructions on page 27 for a forecast using the explanatory method.

## Explanatory Method

It takes five steps to prepare a forecast using the explanatory method.

1. Plot the annual historical consumption against the number of house connections for each historical year on the double logarithmic graph paper on page 29.

2. Fit a straight line connecting the points of historical data, and extend the line.

3. Project the number of house connections in 1980 using the semilogarithmic paper on page 30. Plot historical data on house connections for each historical year, fit a line through the points and extend the line to project the house connections in 1980. In reality, the utility's planned number of house connections, according to investment plans, would be the basis for the connection forecast.

4. Record the projected number of house connections in 1980 on the graph paper on page 30 where you plotted historical consumption. Use it to read off the total consumption projected for 1980.

5. Obtain the projected levels of unaccounted water from the previous two forecasts you prepared and calculate the final forecast using the equation below.

$$\text{Production Forecast} = \frac{\text{Consumption Forecast}}{(1 - \%\ \text{Unaccounted Water})}$$

**Explanatory Method**
(continued)

1. When you are ready to review the groups' forecasts using the explanatory method, ask a representative of each group to display the calculation of the final production forecast on the board or flipchart. Ask the groups to compare their forecasts and to discuss the reasons for any differences among them.

2. According to the graphical forecasts, the number of house connections would be 440,000, the 1980 consumption would be 270 million $m^3$ and the 1980 production would be $\frac{270}{1-0.24} = 355$ million $m^3$.

3. The actual data for the period 1970 - 1980 are shown below.

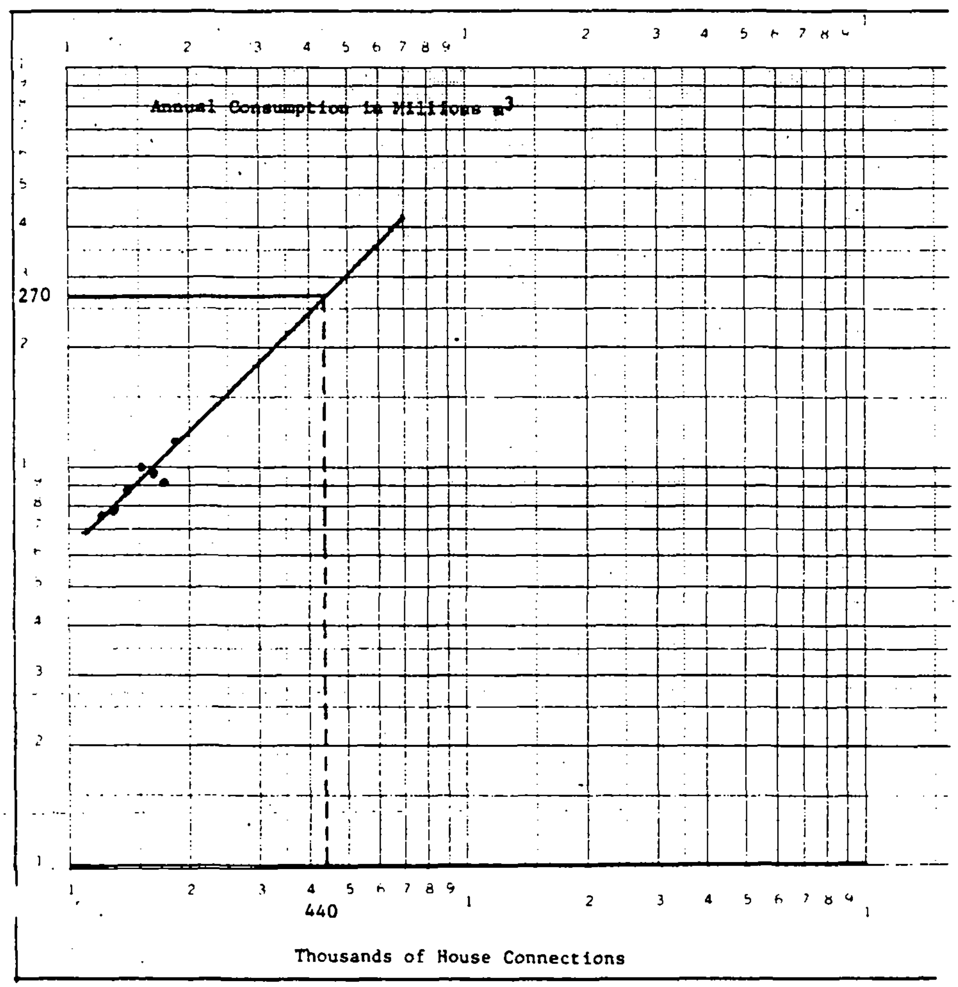
| Year | Consumption by House Connections (in Millions $m^3$ per year | Production (in Millions $m^3$ per year) | Water Un-Accounted For | Number of House Connections | Total Population (Millions) | Population with House Connections |
|---|---|---|---|---|---|---|
| 1970 | 143 | 191 | 25% | 224,000 | 2.41 | 75% |
| 1971 | 147 | 196 | 25% | 238,000 | 2.55 | 77% |
| 1972 | 160 | 216 | 26% | 255,000 | 2.70 | 78% |
| 1973 | 172 | 246 | 30% | 282,000 | 2.86 | 82% |
| 1974 | 183 | 253 | 28% | 302,000 | 3.02 | 82% |
| 1975 | 197 | 253 | 22% | 323,000 | 3.19 | 83% |
| 1976 | 205 | 265 | 23% | 345,000 | 3.28 | 84% |
| 1977 | 208 | 286 | 27% | 369,000 | 3.57 | 85% |
| 1978 | 208 | 299 | 30% | 393,000 | 3.79 | 86% |
| 1979 | 209 | 314 | 34% | 413,000 | 3.87 | 88% |
| 1980 | 223 | 339 | 34% | 433,000 | 3.95 | 90% |

## Explanatory Method
(continued)

Use the space below for your notes or calculations.

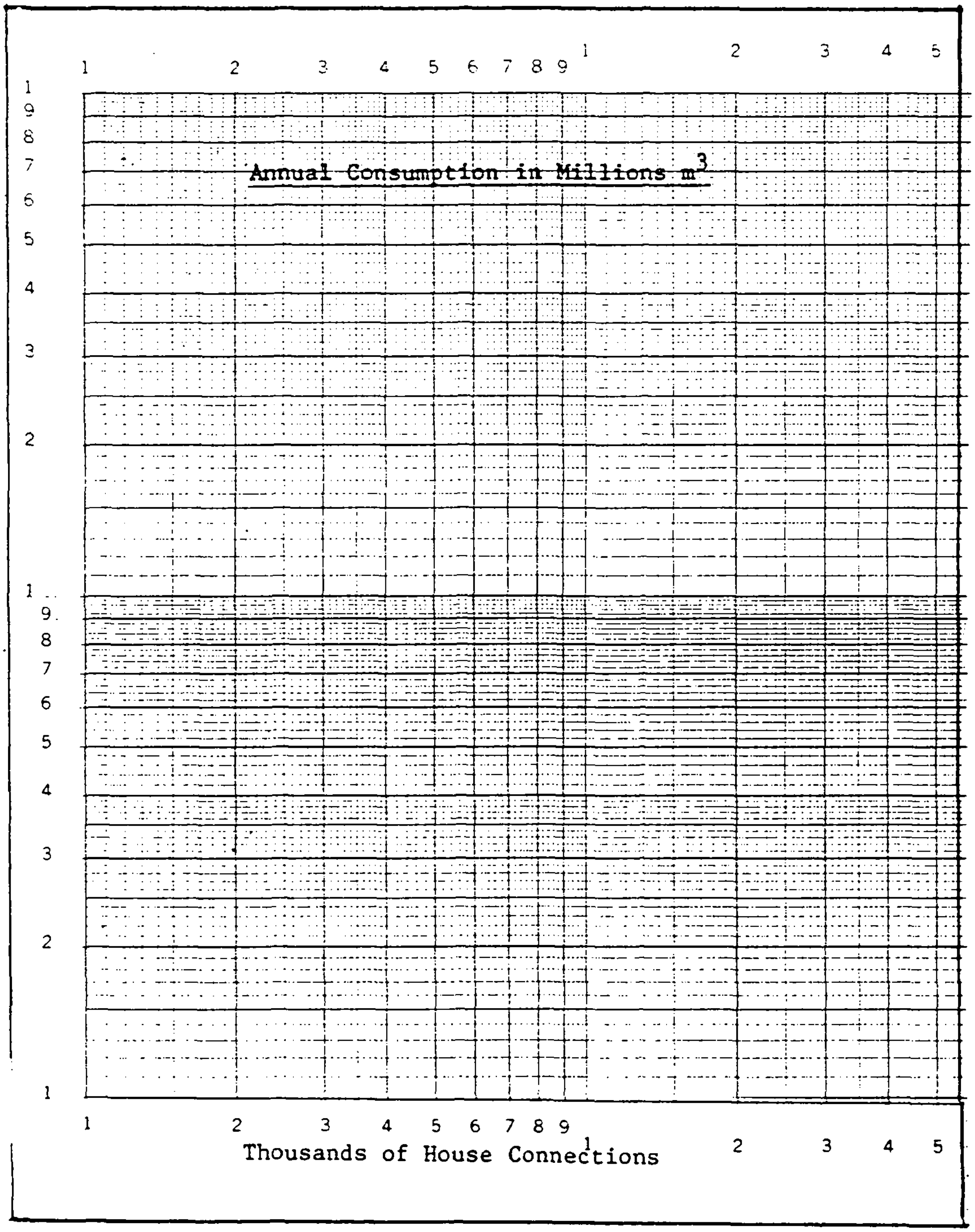
**Explanatory Method**
(continued)

4. The graph for the projected annual consumption is shown below. (Because fitting a free hand line in order to project data is imprecise, the participants' graphs may vary slightly.)



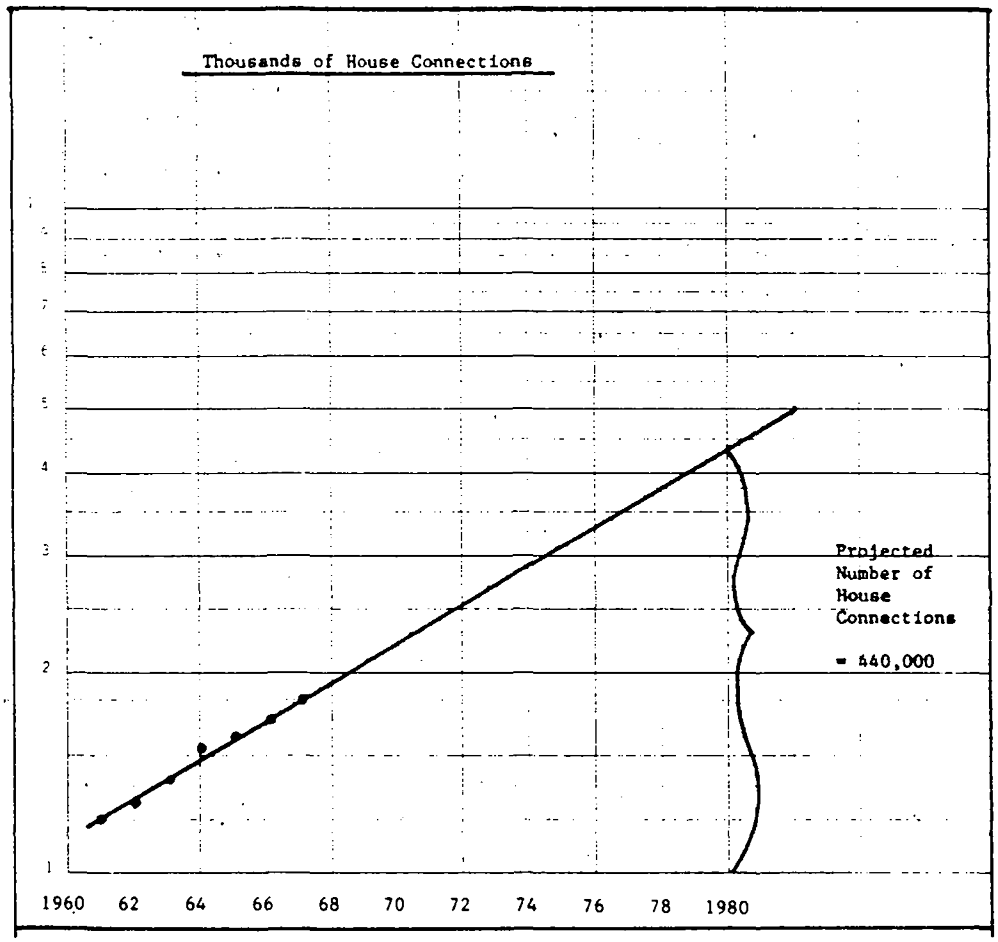
## Explanatory Method
(continued)

Plot the historical data and project future data for annual consumption on the graph paper below.



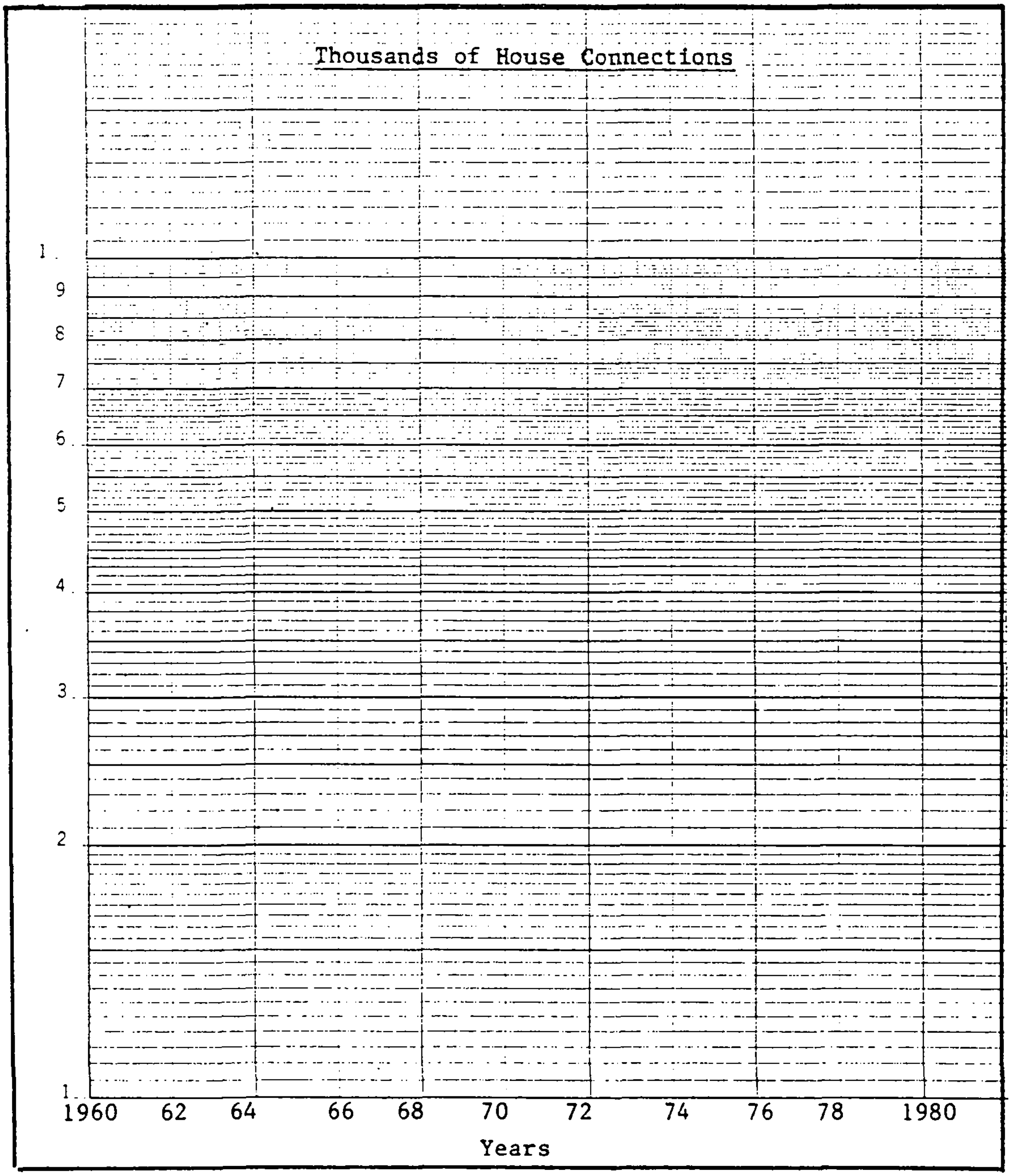
**Explanatory Method**
(continued)

5. The graph for projected house connections is shown below. (Because fitting a free hand line in order to project data is imprecise, the participants' graphs may vary slightly.)



## Explanatory Method
(continued)

Plot the historical data and project future data for house connections on the graph paper below.



**Analysis and Comparison of Methods** Time required: 20 minutes

1. After you have reviewed the three forecasts that the participants prepared, assist them to compare the methods against the criteria listed on page 31. The participants should recognize that each of the methods may be more appropriate under certain circumstances or with certain projects.

2. Conclude the activity by assisting the participants to plan how they can use the information on forecasting methods for the projects with which they work. Ask them to identify any obstacles to accurate data collection and forecasting so that you can help them identify solutions or alternatives.

## Analysis of Forecasting Methods

Now that you have had an opportunity to use all three forecasting methods, discuss them with the other members of your group. Analyze and compare the three methods using the criteria listed below.

- Ease or Difficulty

- Availability of Data

- Accuracy

- Inclusion of Important Determinants

- Reliability in Long-Term Forecasts

- Based upon Controllable Factors

INSTRUCTOR NOTES

**Conclusion** Time required: 10 minutes

1. Summarize the content covered in the module and assist the participants to identify ways that they can apply the techniques of demand forecasting to the projects with which they work.

2. Point out that the next pages include copies of the visuals and narrative text from the slide/tape program.

**DEMAND FORECASTING**

SLIDE/TAPE PROGRAM VISUALS AND NARRATION

DEMAND FORECASTING - PART I

1. 


TITLE SLIDE: Demand Forecasting
Part I

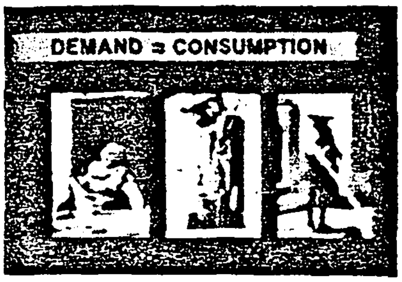
2. 

NARRATOR:
Development projects, like these, are often undertaken in order to satisfy present and future demand. In the case of these projects, the objective is to meet the community's demand for safe water.

3. 

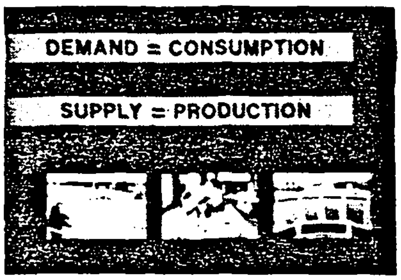

Demand forecasting is the technique used to estimate a community's future needs. Those needs, in turn, are the basis for deciding which projects are necessary and when they should occur.

4.



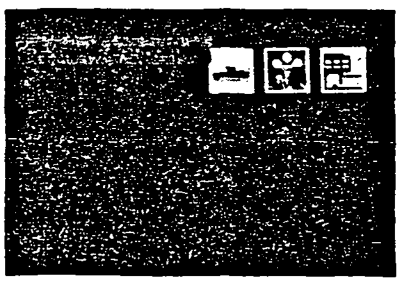

The term demand describes the quantity of water that the community wants for consumption. Because demand and consumption are often synonymous, when we discuss how to forecast demand in this program, we will mean how to forecast consumption.

5.

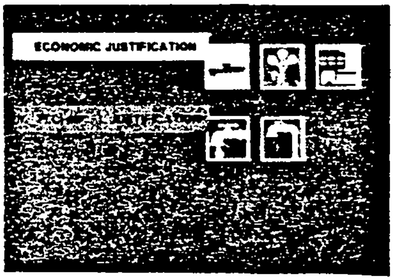



The term supply describes the production levels that will be necessary in order to meet future consumption. Supply forecasts, therefore, are based on consumption forecasts.

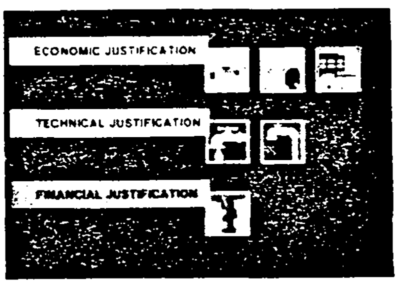
6.



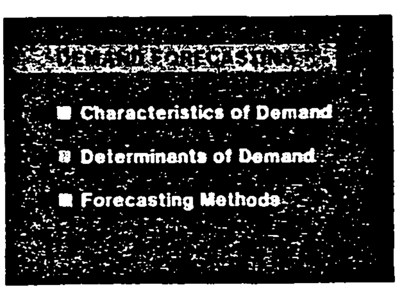
Demand forecasting is important to the economic justification of projects. Overestimated demand leads to projects that are unnecessarily large and waste scarce resources, including land, labor and capital. Underestimated demand results in undersized projects that fail to meet demand.

7. 

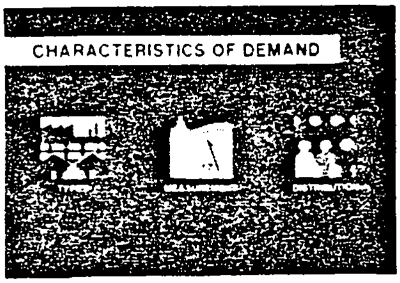

Second, accurate demand forecasts are important to the technical justification of projects. Inaccurate forecasts can lead to projects that are sized and timed incorrectly. As a result, those projects do not represent the least cost solution to meeting the community's needs. And they are too complex or limited to produce the intended benefits.

8. 

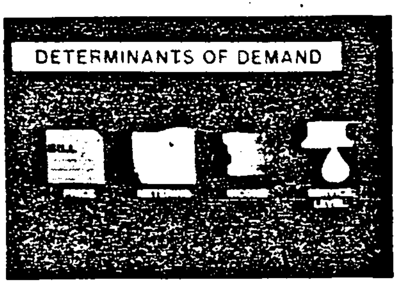

Third, accurate forecasts are important to the financial justification of projects. Overestimated demand leads to overly optimistic revenue projections. In this case, financial crises result when projects must be paid for despite the inadequate levels of revenue.

9. 

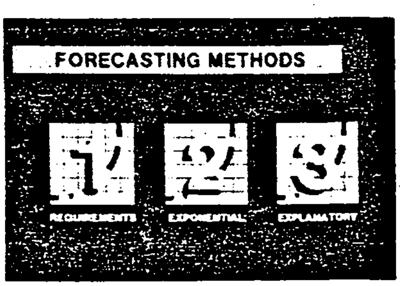

In this program, we will review the three elements to consider when forecasting demand. They are: the characteristics of demand, the determinants of demand, and forecasting methods.

10. 

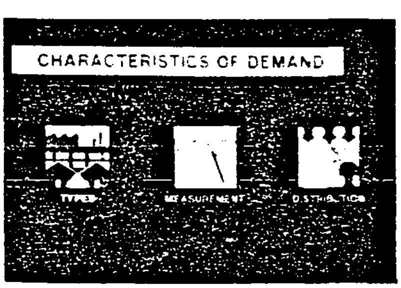

First, the characteristics of demand. We will review the different types of demand, how demand is measured and how consumption is distributed among the people in a community.

11. 


Second, we will identify the major determinants of demand. Determinants include the price of water, the extent of metering, the consumers' income and the service level provided.

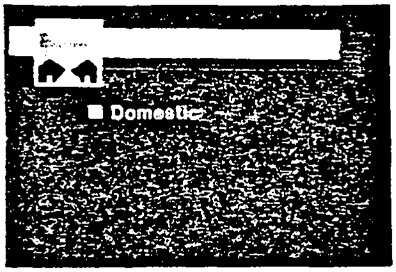
12. 


And, third, we will examine how to prepare forecasts using three methods: the requirements methods, the exponential method and the explanatory method.

13. 

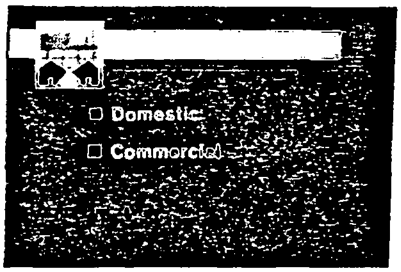

Now we will turn our attention to the first element, the characteristics of demand. We will begin with the types of demand found in most communities.

14.



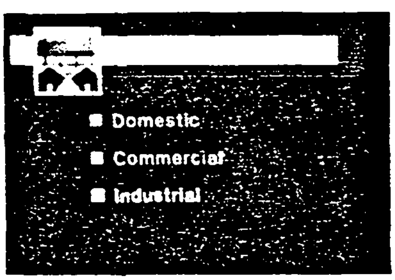

One type is domestic demand for water to be consumed at home.

15.

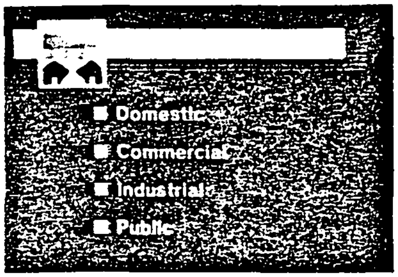



Another type is demand for water from the commercial sector...which can be significant, particularly, in service-oriented cities.

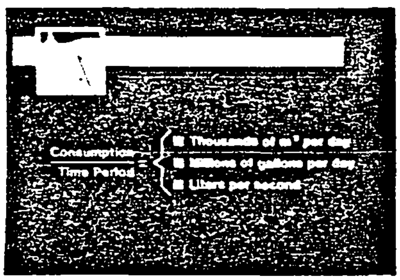
16.



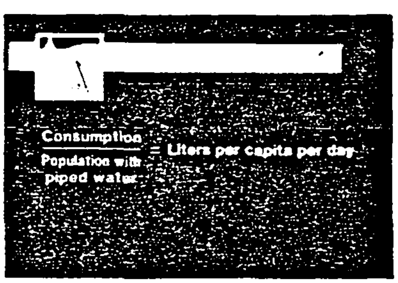

The industrial sector also has demands for treated water. In some cases, large industries may even require their own water supply.

17. 

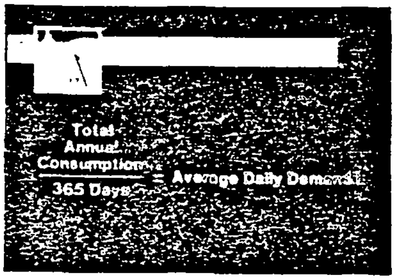

And, the public sector, including government buildings, hospitals and schools, represents yet another type of demand.

18. 

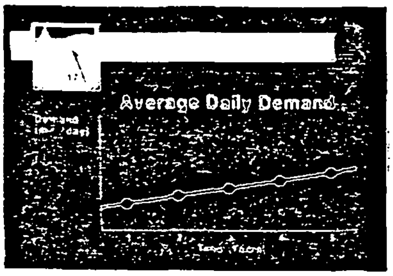

Next, we will review how demand is measured. One way to measure demand is to identify the quantity of water that the community consumes during a specific period of time. Water consumption can be measured in thousands of cubic meters per day, in millions of gallons per day, or in liters per second.

19. 

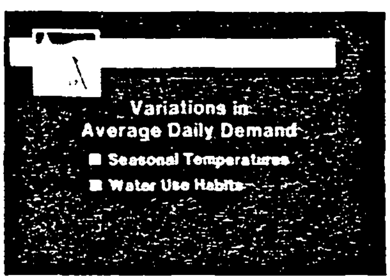

Another way to measure demand is in liters per capita per day based on the number of people who have access to piped water. For example, a community's consumption level may be 250 liters per capita per day, including domestic, commercial, industrial and public sector consumption.

20. 

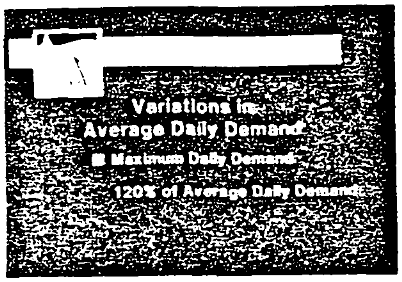

Usually, a community's demand is expressed in terms of average daily demand levels. Average daily demand is calculated by dividing total annual consumption by the 365 days of the year.

21. 

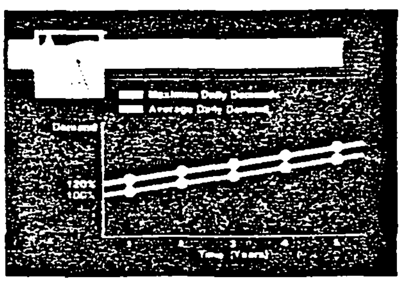

Average daily demand can be plotted on a chart such as this one. The vertical axis represents demand, and the horizontal axis shows time. When demand is plotted for a number of years, the result is the community's average daily demand curve.

22. 

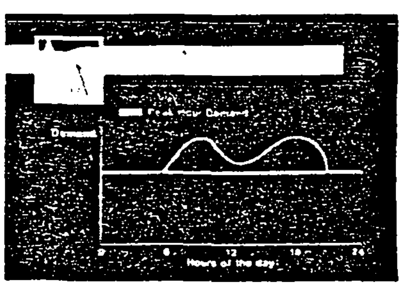

Two factors contribute to variations in average daily demand: seasonal temperatures and water use habits. During the hottest seasons, consumption of water will increase. The population's water use habits during certain days of the week may also affect demand. For example, more water may be required on the days when clothes are typically washed.

23. 

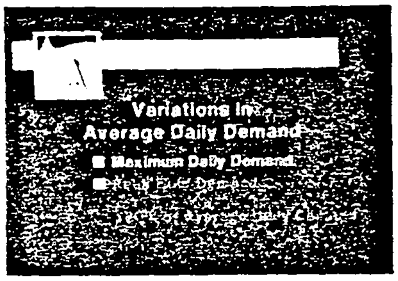

Daily variations in demand can be calculated as a percentage of the daily average demand. One variation is termed maximum daily demand. It describes the level of consumption on the day of the year when consumption is the highest. It is often set at 120% of average daily demand, but the precise percentage will depend on the size of the community and the climate conditions.

24. 

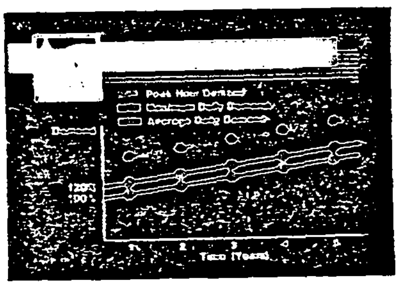
This chart shows maximum daily demand in relation to average daily demand. Maximum daily demand is parallel to average daily demand over time, at a level 20% above average daily demand.

25. 

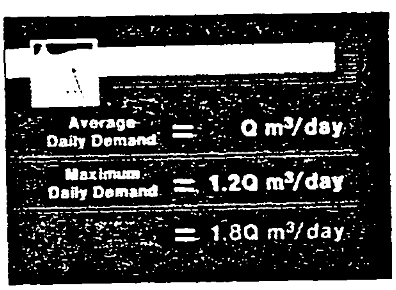
A second daily variation is described as peak hour demand. Consumption varies during the 24 hours of the day, as shown on this chart. Demand peaks in the morning and in the early evening hours when consumption is the highest. Demand is lowest during the night hours when the least water is consumed.

26. 

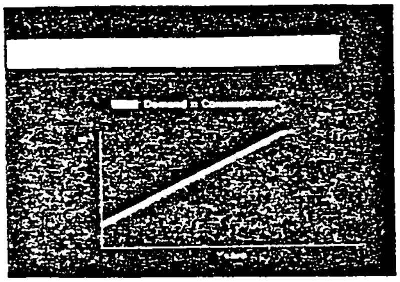

Peak hour demand is substantially higher than both average daily demand and maximum daily demand. Usually, it is set at 180% of average daily demand. The actual peak hour rate will be higher for smaller communities and lower for larger communities.

27. 

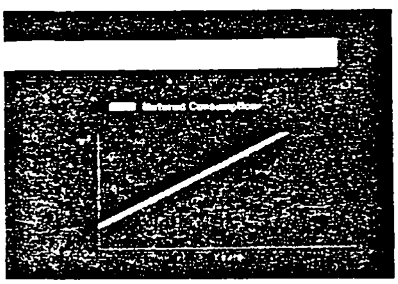
Here, peak hour demand is plotted on a chart with average daily demand and maximum daily demand. The line representing peak hour demand is parallel with the others, but at a level 80% higher than average daily demand.

28. 

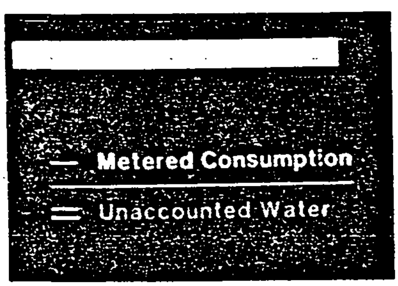

In conclusion, demand levels can be measured and expressed as percentages of the community's average daily consumption. Q cubic meters a day represents average daily demand. Maximum daily demand in this case is 1.2 times average daily demand, or 1.2Q cubic meters per day. And, peak hour demand is 1.8Q, or 1.8 times average daily demand.

29. 

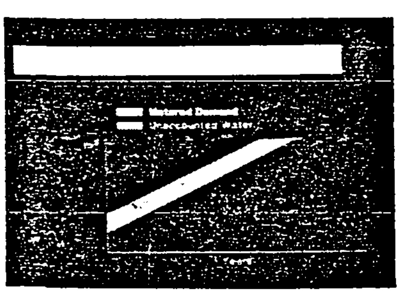
Next, we will turn our attention to supply. Supply is the production level needed to satisfy demand, or consumption. Supply can be plotted along with demand on a chart such as this one.

30. 

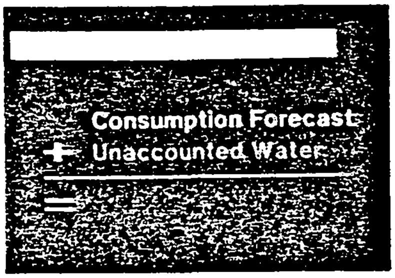
The levels of production and consumption discussed so far are the levels that are accounted for, or measured, in some way, such as metering.

31. 

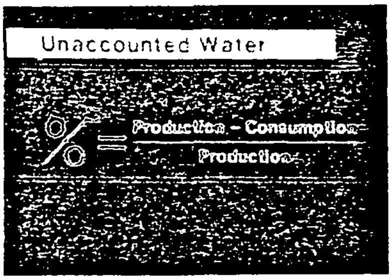

The difference between metered production and actual consumption is termed unaccounted water. It is the amount of water that is supplied but does not generate any revenue or is not measured through metering.

32. 

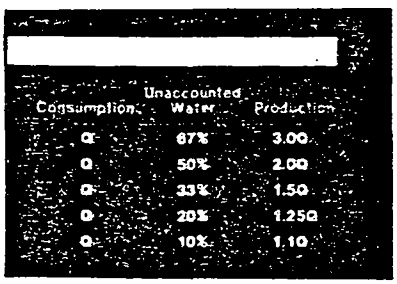
In this case, the unaccounted water is the highlighted area on the chart. Like supply and demand, unaccounted water can also be described in thousands of cubic meters per day.

33. 

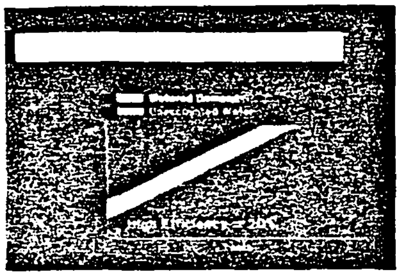

It is important to add an amount for unaccounted water to consumption forecasts in order to prepare forecasts that accurately reflect the required supply.

34. 

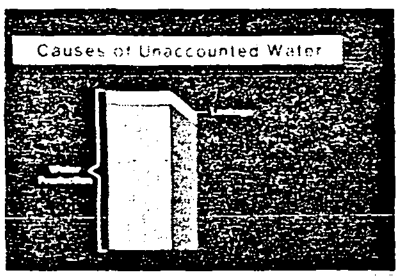

Usually, unaccounted water is expressed as a percentage of the amount of water that is produced. In order to calculate unaccounted water, first consumption is subtracted from production. Then, the remainder is divided by production.

35. 


This chart shows the water production that is required with different percentages of unaccounted water. Q represents the consumption level. If unaccounted water is at 67%, then the chart shows that the water produced must be triple the amount of water that is consumed, represented by 3Q on the chart. A 50% level of unaccounted water requires production that is double the level of consumption, expressed as 2Q. As this chart shows, the production levels required decrease if the percentage of unaccounted water decreases.

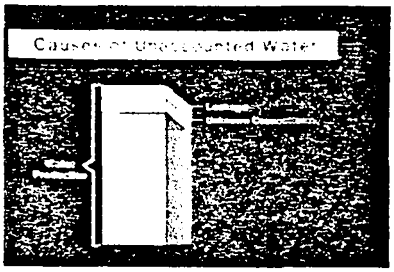
36. 

The level of unaccounted water is one indicator of the efficiency of a water supply system. It is important, therefore, to keep the percentage of unaccounted water as low as possible. A high level of unaccounted water signals that more consumption could be satisfied with existing water production levels. An efficient system is one where unaccounted water is 20% or less.

37. 

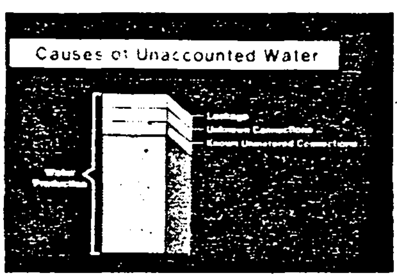

Next, we will review some causes of unaccounted water. Leakage is one cause. A portion of the water produced is lost because of leaks in the distribution system. The actual amount lost will depend upon the age and condition of the pipe as well as the condition of the surrounding soil.

38.

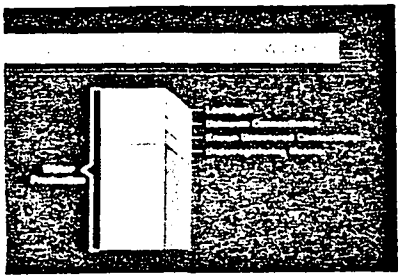


Some more water will be consumed through unknown or illegal connections to the distribution system. These connections are unmetered and, therefore, the water consumed is unaccounted.

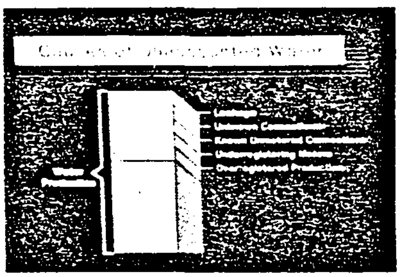
39.



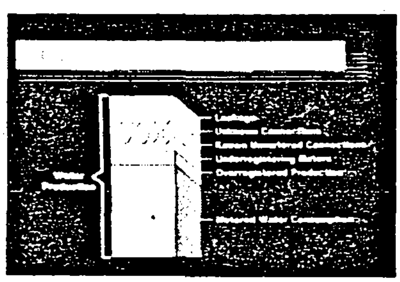

A third source of unaccounted water is known, but unmetered connections. In some cases, communities meter very few connections. In other cases, the community may not meter certain facilities, such as schools, hospitals, and government buildings, because they are exempt from paying tariffs.

40. 

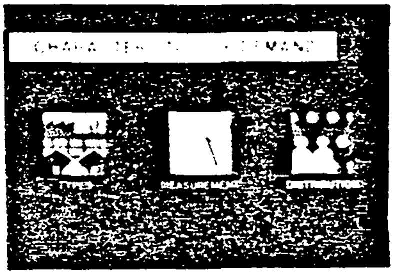
A fourth cause of unaccounted water comprises the meters that underregister the actual amounts of water consumed.

41. 

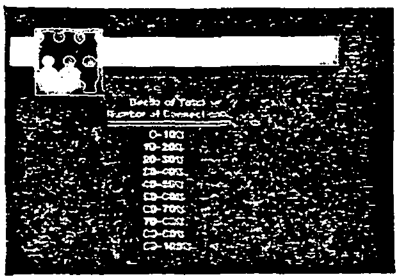
And, fifth, faulty production meters may overregister the amount of water that was produced. This will make unaccounted water seem higher than is actually the case. Of all the causes of unaccounted water, typically, leakage is the least important.

42. 

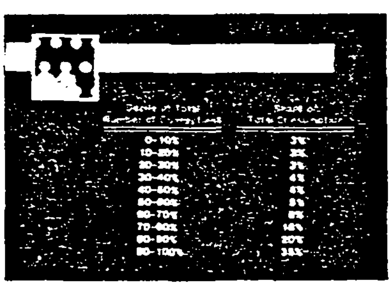
It is common for the percentage of total unaccounted water to amount to 30% of total water produced. In the best managed and most efficient facilities, the percentage of total unaccounted water amounts to only 10% of the total water produced.

43. 

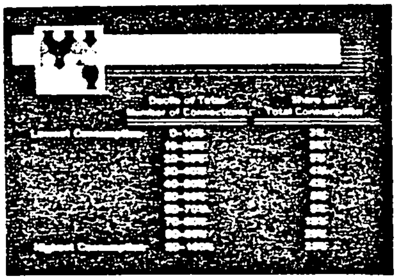

The third characteristic of demand that we will discuss is the distribution of demand in the community.

44. 

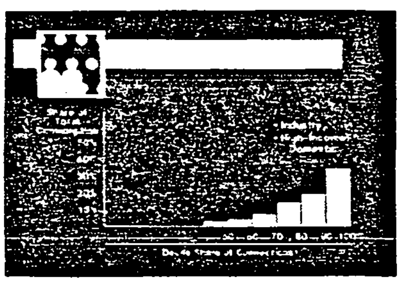
Metering data is a source of information for compiling statistics on the distribution of consumption in a community. In this statistical table, all of the house connections in the community are divided into deciles, that is, increments of 10%. Each decile is listed in ascending order of its consumption level.

45. 

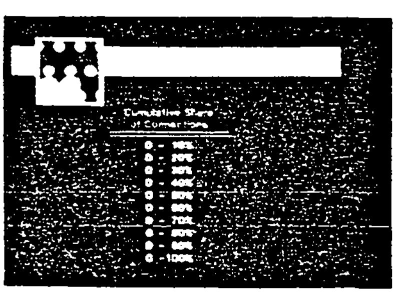
Then, a relative share of the total water consumed in the community is assigned to each decile.

46. 

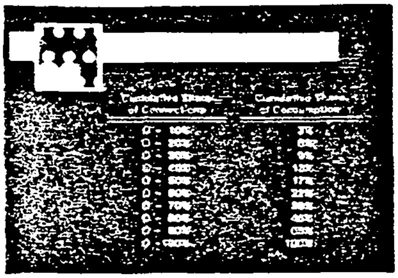
This chart shows that the 10% decile, the group with the lowest consumption, consumes only 3% of all water supplied. The 90 to 100% decile, the group with the highest consumption, accounts for 35% of all water consumed. In terms of average consumption, the 90 to 100% decile consumes 10 times more water than the 10% decile.

47. 

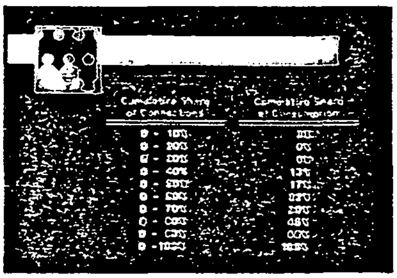
Another way to show the distribution of consumption in a community is a bar chart. This one shows each decile's share of total metered consumption. Low income, domestic consumers use relatively very little water. Industrial and high income domestic consumers account for significantly higher consumption.

48. 

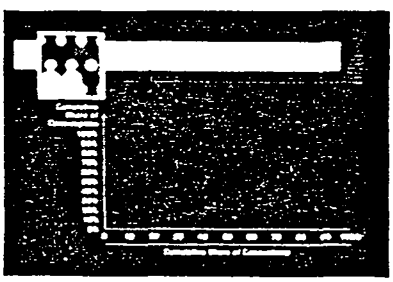
This chart shows the cumulative share of connections in ascending order of consumption.

49. 

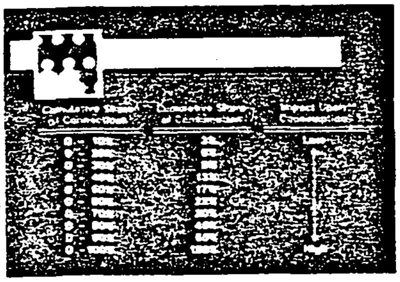
Then, each cumulative share of connections is shown next to its share of total water consumption.

50. 

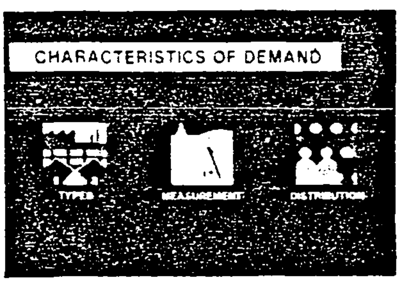
In this case, the group that represents 40% of all house connections in the community consumes only 13% of the total water. Most likely, these are low-income, domestic consumers.

51. 

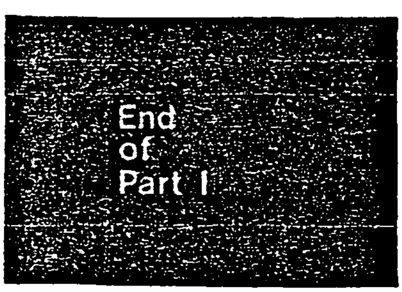
A summary chart, such as this one, is useful for showing the cumulàtive percentage of house connections for each group and its corresponding cumulative percentage of consumption.

52. 

These distribution figures are valuable when forecasting demand. Among other things, the figures show that adding house connections will have a different impact on consumption, depending upon which consumer groups are connected. On the one hand, connecting more low-income households will have a minimal impact upon total water consumption. On the other hand, increased connections for high-consuming groups will have a much greater impact upon consumption.

53. 

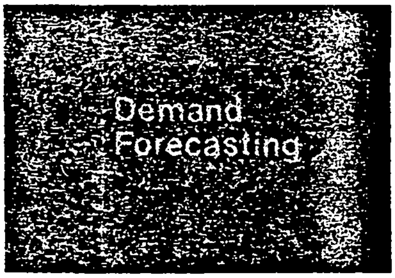

In summary, demand forecasting first requires an understanding of the characteristics of demand. Specifically, the characteristics of demand involve understanding the different types of demand, how demand is measured and how consumption is distributed in the commmunity.

54. 

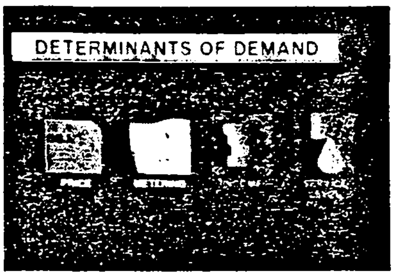

This concludes the first part of the program on demand forecasting.

(End of Part 1)

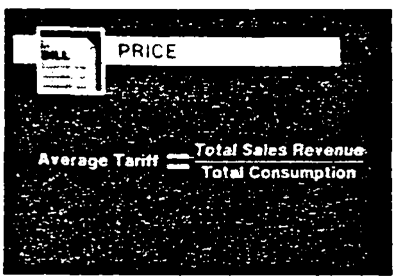
# DEMAND FORECASTING - PART II

55. 

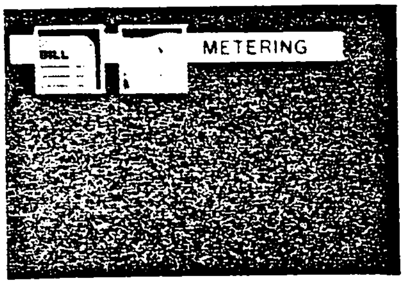

Title slide: Demand Forecasting
Part II

56. 

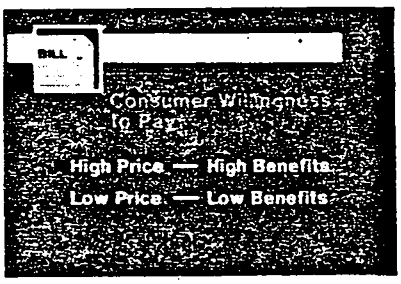

In this part of the program, we will discuss the determinants of demand, beginning with price and metering.

57. 

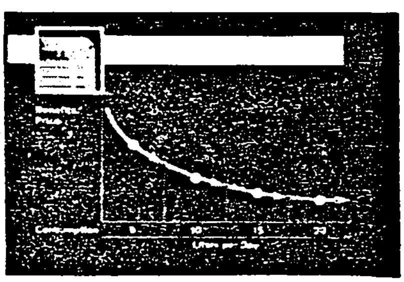

The price of water is equal to the tariffs that are charged for it. Price is usually expressed as an average tariff per cubic meter of water consumed. The average tariff is calculated by dividing the total sales revenue by total metered consumption.

58. 

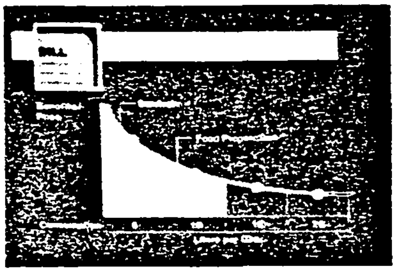

The price of water influences consumption levels only when consumption is metered. Because metering is so closely linked with price, the two will be discussed together in this part of the program.

59. 

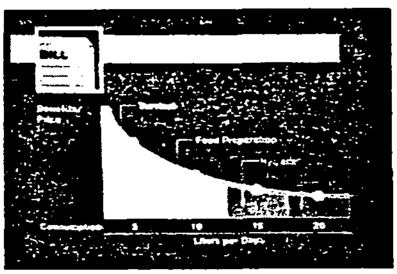

The price that consumers will pay for certain amounts of water reflects their perception of the benefits they receive from that water. Consumers will pay a high price for water that provides them with a high level of benefits. They will pay less for water that they believe provides them with fewer direct benefits.

60. 

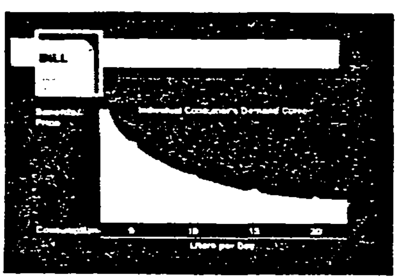

This demand curve shows that the price that consumers will pay for water reflects the benefits they perceive they are getting. Consumers will pay a high price for water that provides a high level of benefits. As the arrow indicates, consumers will pay less for water that provides fewer benefits. Next, we will examine some reasons for the differences in benefits perceived and the prices that consumers will pay.

61. 

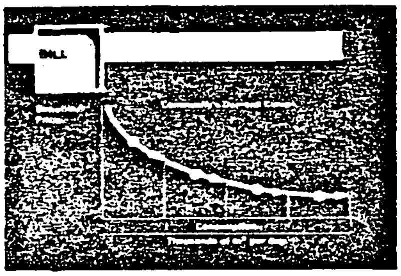
If the consumer is without any water, his need for it in order to survive will be acute. He will pay a very high price for this critical amount of water because he perceives the benefits of this amount of water to be equally high. The consumer may also need additional water for food preparation. This is important, but less vital, so the consumer will pay somewhat less for this amount of water.

62. 

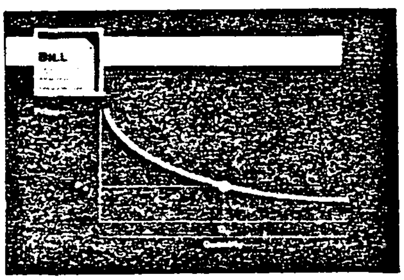
The consumer will pay even lower prices for additional amounts of water for hygiene. And, he will pay the lowest prices for other, non-critical uses of water. This demand curve, then, shows the decreasing prices that consumers will pay based upon the value they place on each amount of water.

63. 

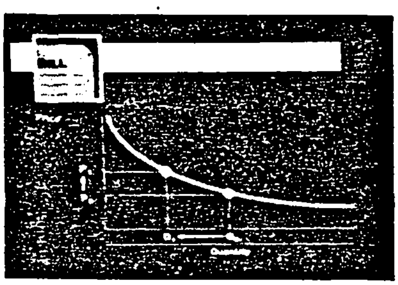
The shaded area under the demand curve represents the total economic benefits perceived by the average consumer.

64. 

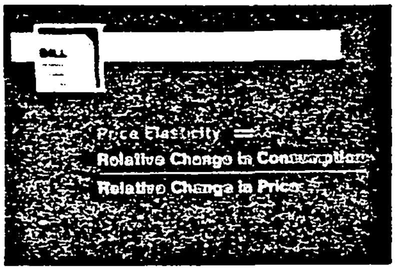
In addition to an individual consumer's demand curve, it is also possible to depict a community's demand curve as well. A community's demand curve will show the same trends. This is because a community also will pay according to the benefits that the water provides.

65. 

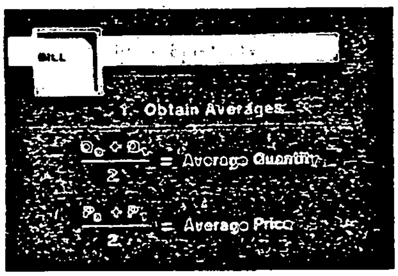
Price changes, however, can affect demand, both in the long and short term. To illustrate this point, we will use the example of an individual who is consuming a quantity of water represented by $Q_0$ on this chart. For that amount of water, the individual consumer is paying a price represented by $P_0$.

66. 

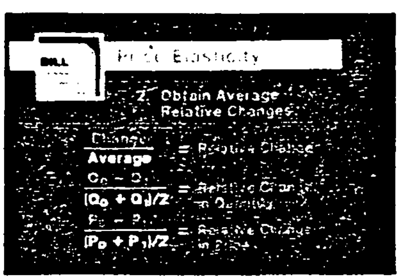
If the price is increased from $P_0$ to $P_1$, the individual will consume less water. As a result, the quantity of water he consumes each day will decrease, from $Q_0$ to $Q_1$.

67. 

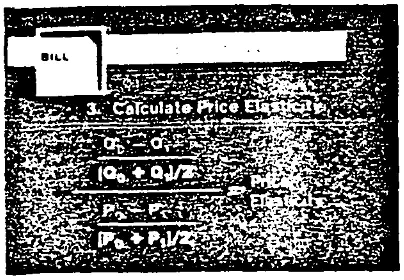

Price elasticity is the indicator used to measure how much demand will increase or decrease if prices rise or fall. Price elasticity is calculated by dividing the relative change in water consumption by the relative change in price. That calculation requires three steps.

68. 

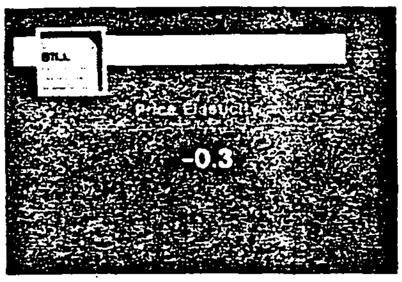

The first step is to calculate the average price and average quantity. In these equations, Q represents the quantity of water consumed and P represents the price paid for the water. The average quantity is obtained by dividing $Q_0$ plus $Q_1$ by 2. The average price is obtained by dividing $P_0$ plus $P_1$ by 2.

69. 

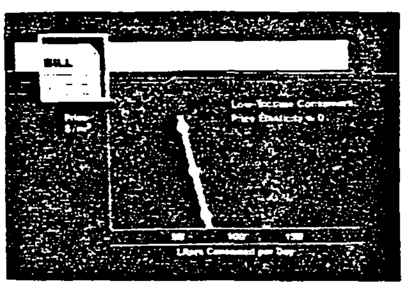

The second step is to calculate the average relative changes in both quantity consumed and price paid. The relative change in quantity is calculated by subtracting $Q_1$ from $Q_0$. The relative change in price is obtained by subtracting $P_1$ from $P_0$. The average relative change is then calculated by dividing the changes by the averages.

70. 

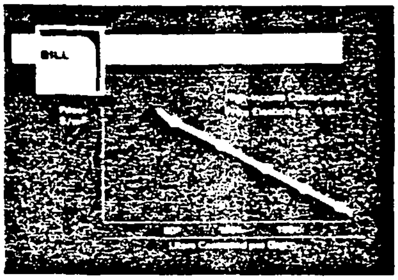

The third step is to calculate the price elasticity by dividing the relative change in quantity by the relative change in price.

71. 

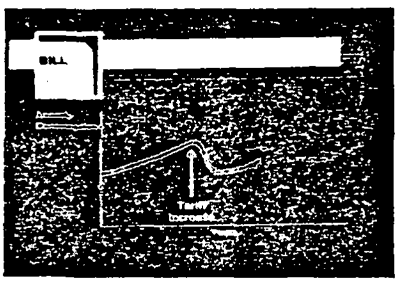

Studies have shown that, in the short-term, price elasticity of water demand is approximately minus 0.3. This means that consumption will decrease an average of 30% if the tariff increases by 100%.

72. 

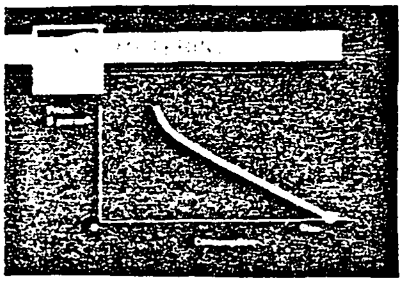
Studies have also shown that the price elasticity for low-income consumers is lower, almost zero. This means that consumption levels for this group will remain almost constant regardless of any price changes. The reason is that this group primarily consumes critical water that provides them with a very high level of benefits.

73. 

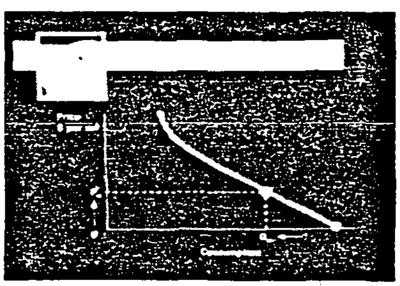
In contrast, the price elasticity for high-income consumers is higher. It is estimated at minus 0.6. The demand curve is not as steep because this group consumes more noncritical water. As a result, if prices increase, this group will tend to decrease its consumption of non-critical water.

74. 

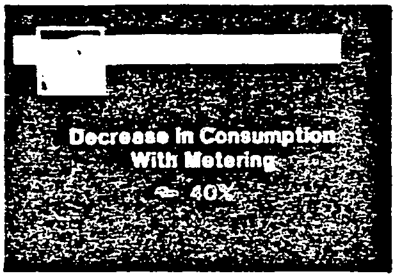
Because price changes do influence consumption, it is possible to use price changes to control the community's demand. For example, if annual demand is increasing so fast that rationing may soon become necessary, a tariff increase can be used to curb demand. When the tariff increase reduces demand, then the community will gain some additional time before it must increase production.

75. 

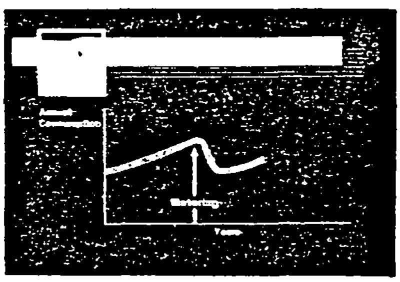
In addition to price changes, metering will also influence demand. This demand curve illustrates the effect that metering has on demand. When metering is absent, the consumer will take advantage of all the water that is available to him, including the least essential amounts of water which generate a low level of benefits. That amount of water is shown on the graph as $Q_{am}$, or the quantity with absent metering.

76. 

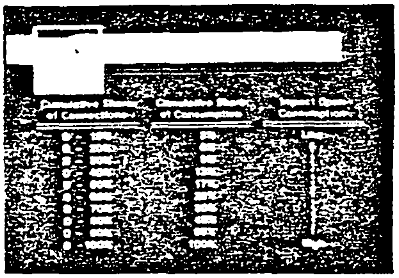
Assume that metering is introduced and that price with absent metering, or $P_{am}$, is raised to $P_m$, the price with metering. Consumption will drop from $Q_{am}$ to $Q_m$ liters per day. In effect, the consumer will reduce his consumption to the point where the benefits from the last liter of water he consumes is equal to the price he must pay.

77. 

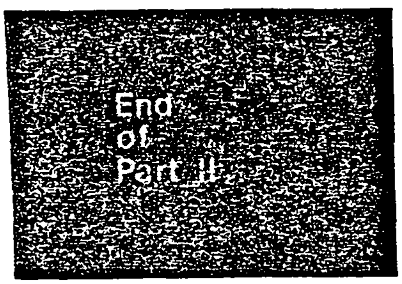

Studies have shown that metering will cause per capita water consumption to decrease approximately 40%. This means that metered consumption is approximately 60% of unmetered consumption.

78. 

Because metering can decrease consumption, it is useful in controlling demand. And, when demand decreases as a result of metering, the community will gain some additional time before having to increase water production.

79. 

This chart shows the cumulative share of consumption by different groups. When metering is introduced, it is best to begin with the higher income consumers and work gradually toward metering the lower-consuming groups.

80. 


This concludes the second part of the program on demand forecasting.

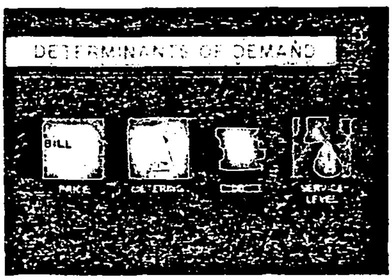
(End of Part II)

## DEMAND FORECASTING - PART III

81.

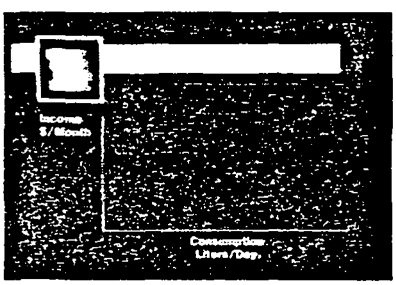

Title Slide: Demand Forecasting
Part III

82.



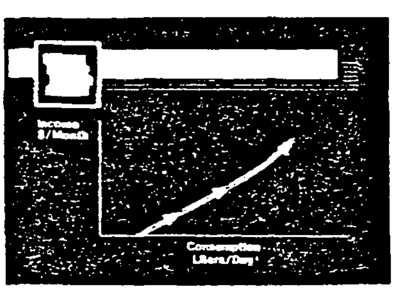

In this part of the program we will continue to review the determinants of demand. Now that we have discussed price and metering, we will turn our attention to income.

83.

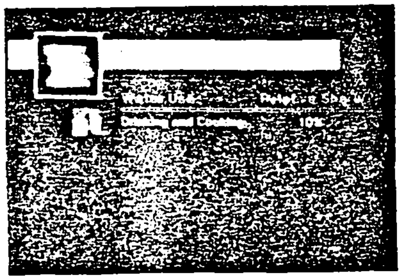



Income levels influence consumption. This relationship can be shown on a graph where the consumer's income in dollars per month is plotted against his consumption in liters per day.

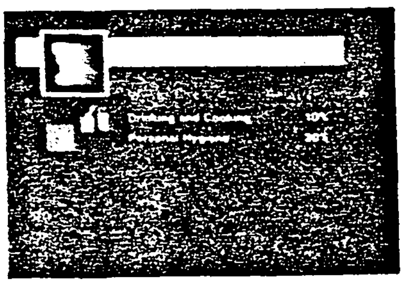
84.



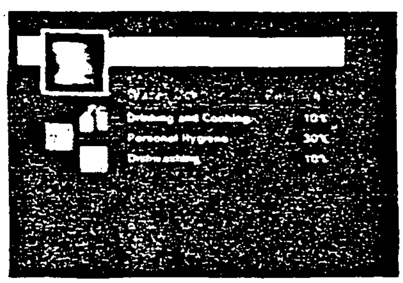

As this curve shows, water consumption increases when consumers have more income per month. Higher income increases consumption for two reasons. First, more money is available to pay for consumption. And, second, consumers can afford more water-using appliances and sanitation facilities.

85. 

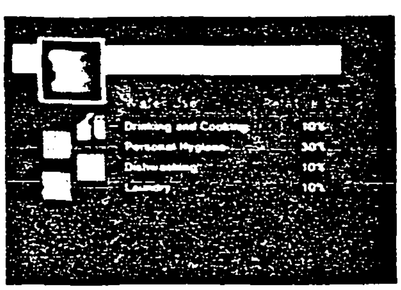
The relative share of the different uses that consumers make of water illustrates the importance they place on increasing amounts of water. The most basic need is water for drinking and cooking. Almost 10% of all water consumed goes to this critical use.

86. 

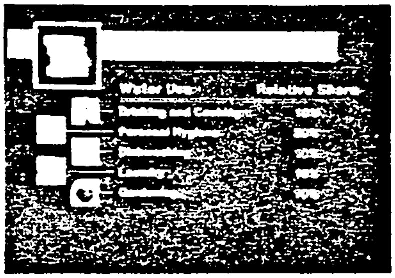
Next, consumers need water for personal hygiene. Approximately 30% of water consumed is used for hygiene.

87. 

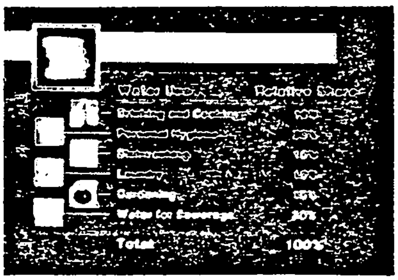
Dishwashing is another use of water, and amounts to approximately 10% of total water consumed.

88. 

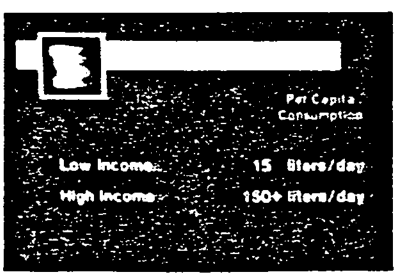
Using water to do laundry consumes another 10%.

89. 

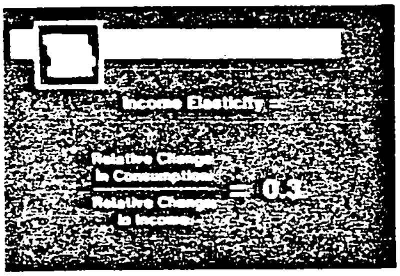

Gardening or non-critical uses of water, such as washing cars, requires another 10%.

90. 

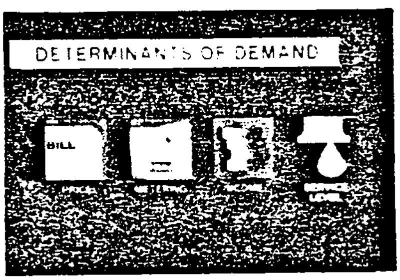
Then, too, water is required to operate the sewerage system, amounting to about 30% of total water consumption. The relative shares on the chart are representative of water consumption in Western Europe.

91. 

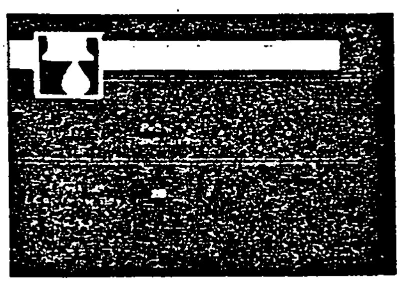

The basic water needed for drinking, cooking, and perhaps hygiene, averages 15 liters per capita per day for a low-income population. The water consumption for a high income population is over 150 liters per capita per day.

92. 

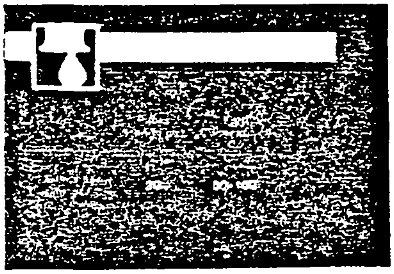

Water consumption changes when income changes. Income elasticity is the term used to describe how much consumption will change when income levels increase or decrease. Studies have estimated income elasticity at 0.3. This means that when income doubles, water consumption increases by 30%.

93. 

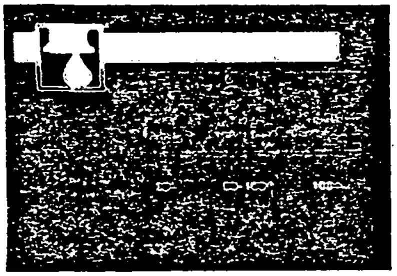

In addition to price, metering, and income, the fourth determinant of demand is the service level. It can have a significant impact upon the demand for water.

94. 

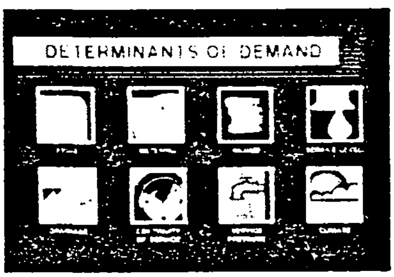
For instance, a community with public standpipes consumes approximately 20 liters per capita per day. The time and physical labor required to obtain additional water discourages consumption from rising much above this level.

95. 

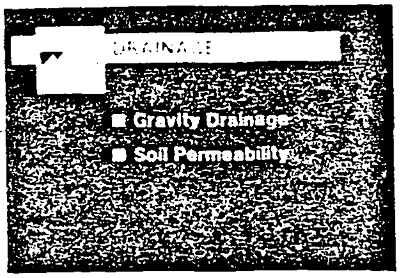
Households with yard connections consume between 50 and 100 liters per capita per day. Water use by this group is higher because the water is more accessible.

96. 

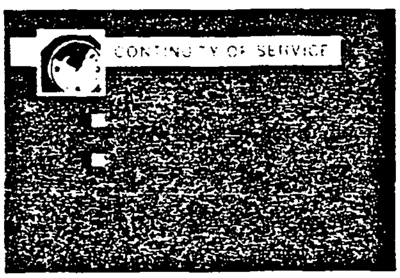
Consumers with house connections or indoor plumbing consume even more water -- 100 or more liters per capita per day. As this chart shows, consumption increases as the service level improves.

97. 

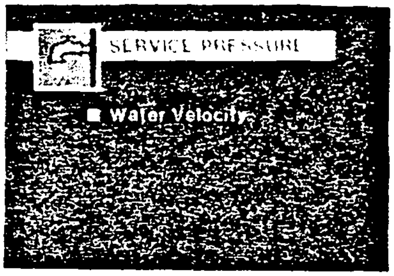

In addition to the four major determinants of demand--price, metering, income and service level--there are other factors to consider as well. These include drainage, the continuity of service, the service pressure and the climate.

98. 

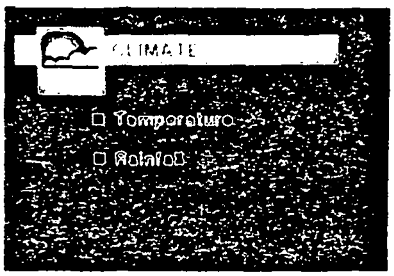

First, drainage. The absence of good water drainage will limit the amount of water that consumers use, unless drainage by gravity is possible. Consumers will decrease their water use to the point where the soil can absorb the wastewater.

99. 

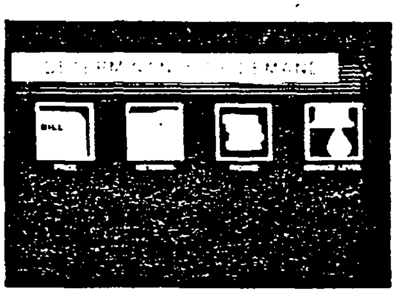
Continuity of service is another factor to consider. Most utilities aim to provide water service 24 hours a day. If this is not feasible, then water is often rationed. But, in many cases, rationing does not discourage water consumption. In fact, it may increase consumption. This is because consumers will collect water to keep on hand while water service is interrupted. Then, when water service resumes, they may discard the stored water and wastefully replace it with fresh water.

100. 

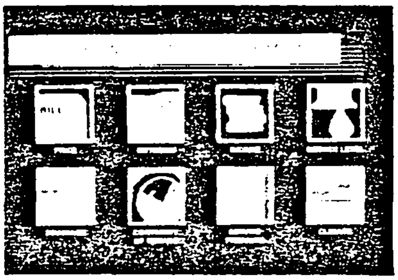

Service pressure should be taken into account because it, too, influences water consumption. Water consumption increases when service pressure is high and water comes out of the tap at a high velocity.

101. 

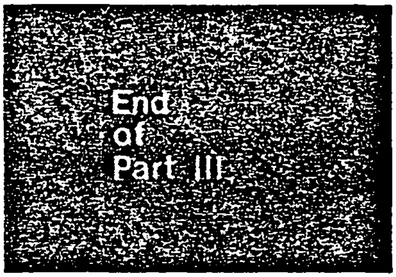

Last, the local climate must be considered as well. On the one hand, water consumption will increase when the temperature is the highest, most often during the dry seasons. On the other hand, consumption will decrease during the rainy seasons when water is more abundant and alternative sources are available.

102. 

In summary, the level of demand for water is determined by a number of factors. The most influential factors are the price of water, the extent of metering, the consumers' income and the water service level.

103. 

The other factors to consider are: drainage, continuity of service, service pressure and local climate.

104. 

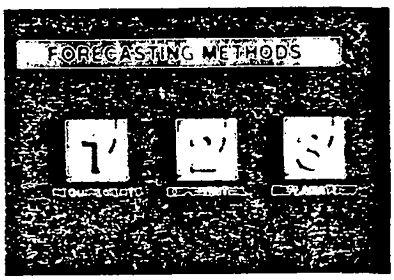

This concludes the third part of the program on demand forecasting.

(End of Part III)

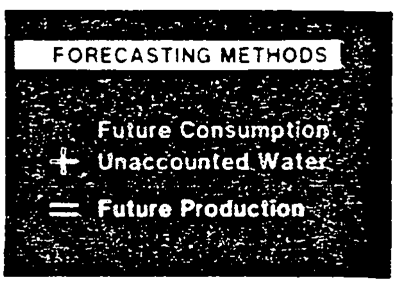
# DEMAND FORECASTING - PART IV

105. 

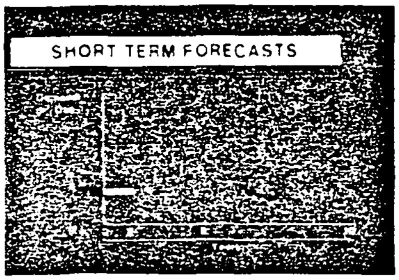

Title Slide: Demand Forecasting
Part IV

106. 

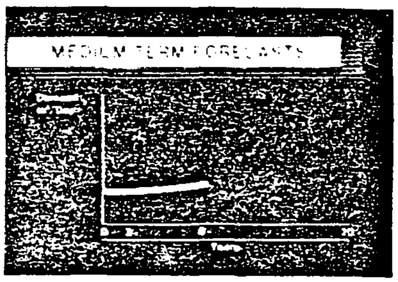

In this part of the program, we will review how to forecast demand using three methods.

107. 

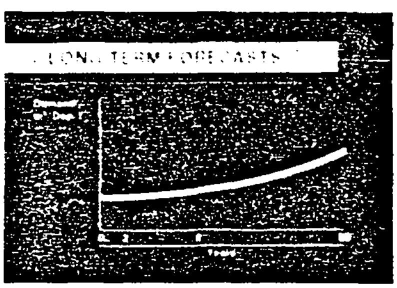

Regardless of the forecasting method used, there are three important variables to consider: the amount water that will be consumed in the future, the amount of unaccounted water and the amount of water that must be produced in order to meet consumption and unaccounted water levels. In effect, the future supply - or production - requirements are equal to future consumption plus unaccounted water.

108. 

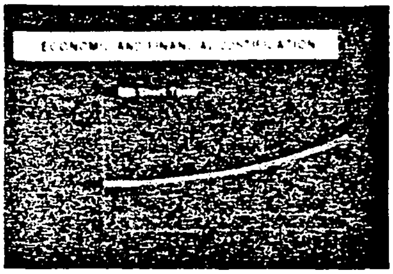

When forecasting future demand, it is useful to consider forecasts at different points in time. This chart is a short-term forecast. It extends two years into the future.

109. 

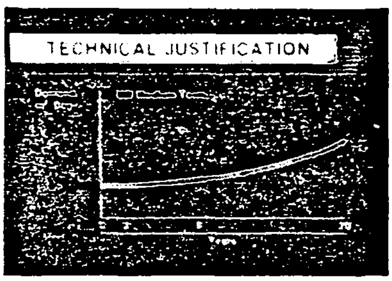
This medium-term forecast is targeted at years 0 through 8.

110. 

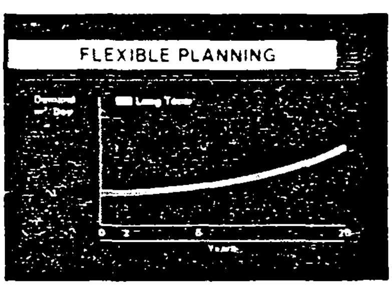
And, this long-term forecast covers years 0 through year 20. Forecasts that extend much beyond twenty years are of little value because the margin of error typically is very high.

111. 

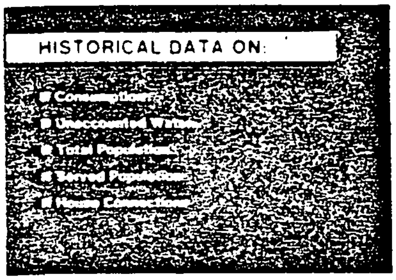
The forecasts prepared for different periods of time can influence the economic, financial and technical justification of projects. For example, errors in short-term forecasts may affect a project's economic justification. This is because overestimated short-term demand will result in premature projects and an unnecessary financial drain.

112. 

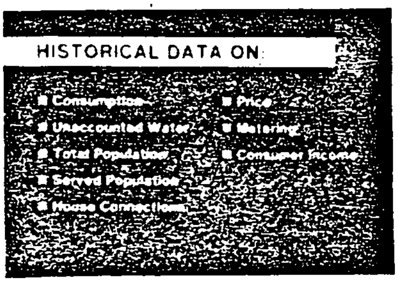

Similarly, errors in medium-term forecasts will endanger a project's technical justification. On the one hand, overestimated demand will result in premature or oversized projects where resources will remain idle. On the other hand, underestimated demand will result in projects that cannot meet demand.

113. 

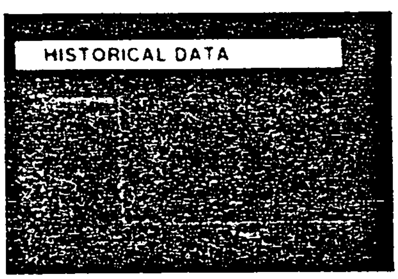

Errors in long-term forecasts are somewhat less serious. In this case, there is time to remedy under- or overestimated demand. Because of the margin of error in forecasts that extend this far into the future, long-term investment planning should be flexible.

114. 

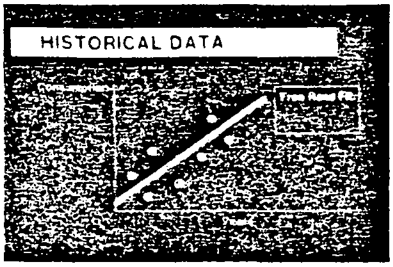

Forecasting future consumption begins with a base of historical data on past consumption levels, the percentage of unaccounted water, the total population, the population served and the number of house connections.

115. 

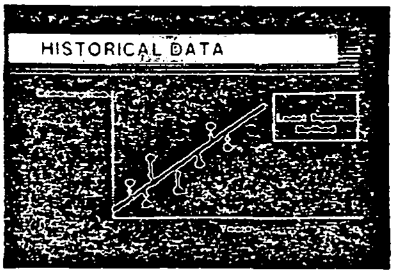

It is also important to consider any expected changes in the price of water, the extent of metering of connections and the consumers' incomes.

116. 

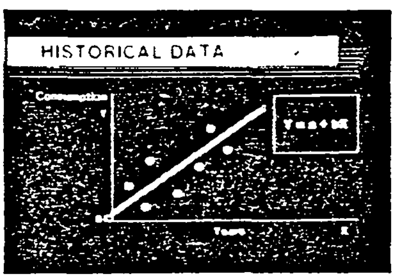

Forecasting consumption requires predicting the future by using historical data. We will use this graph to illustrate how to plot historical data and how to find the curve that will best represent future consumption.

117. 

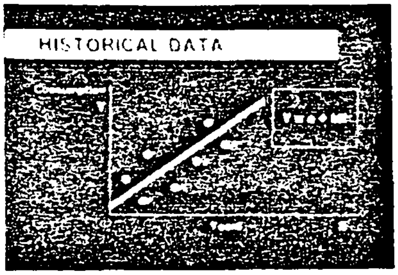

One way to show future trends is to plot the points of historical data on a graph and then draw a line, free-hand, through the points.

118. 

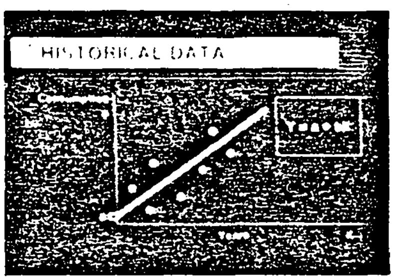

A second way to plot the curve is to use the least squares method. First, the distances between the points and the curve are squared and added. The line is drawn so that the sum of the distances from each point to the line is the least.

119. 

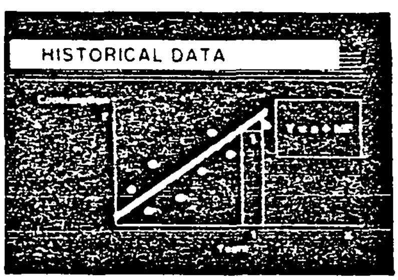

Then, the line is calculated using the equation: Y equals a plus b times x.

120. 

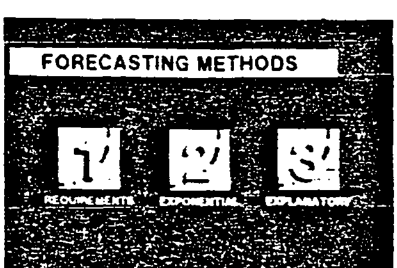

Y is the annual consumption. X represents time in years.

121. 

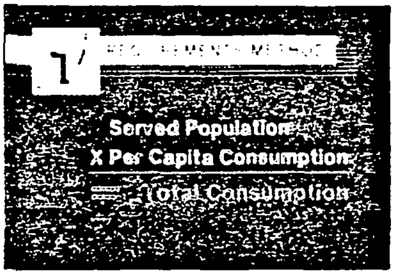

A is a constant. It is the consumption level in year 0 and is the point where the straight line intersects the Y axis.

122. 

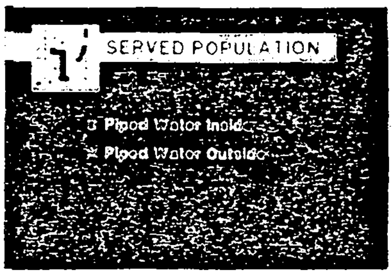

And, b is the slope of the straight line. It describes how much the line will rise each year. Fitting a straight line---using the free-hand method or the least squares method---is the basis for approximating historical data. The approximated historical data, in turn, are important when using any of the three forecasting methods that we will review next.

123. 

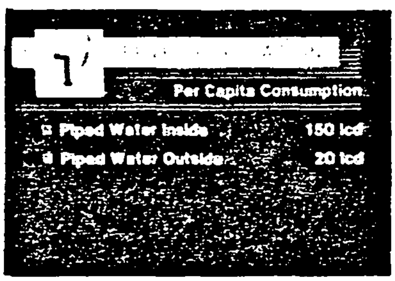

The three forecasting methods are: the requirements method, the exponential method, and the explanatory method.

124. 

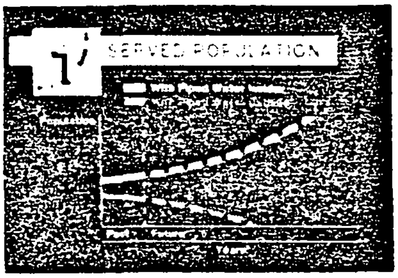

First, the requirements method. This method is based on the assumption that consumption can be forecast by multiplying the served population by its per capita consumption.

125. 

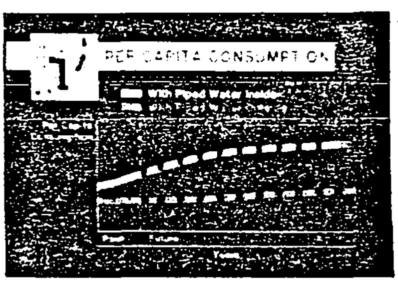

Typically, the served population is separated into two groups: those with piped water inside the home and those with piped water outside the home.

126. 

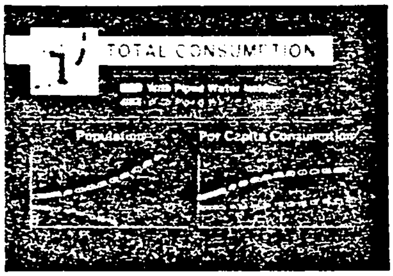

Historical data are used to calculate the per capita consumption data for both groups. In this case, the data show that those with piped water inside the home consume an average of 150 liters per day. Those with piped water outside the home typically consume about 20 liters per day.

127. 

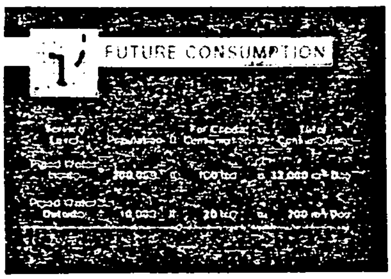

After historical data on the per capita consumption of both groups are prepared, population forecasts can be prepared. Separate forecasts are prepared for the future population that will have piped water inside and the population that will have piped water outside. On this chart, the solid line shows past population data; the broken line depicts estimates of future population numbers.

128. 


In addition to population forecasts, per capita consumption can also be projected for both groups. Metering and price changes should be taken into account when preparing this data. In this case, the chart shows that per capita consumption for those with piped water outside will remain relatively constant while the consumption by those with piped water inside the home will increase slightly over time.

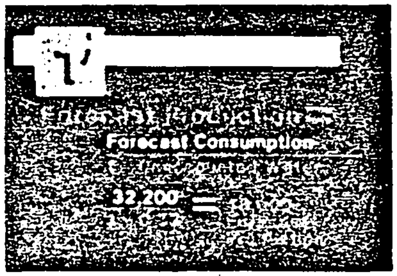
129. 


In order to forecast total future consumption, the information on both population and per capita consumption is combined.

130. 

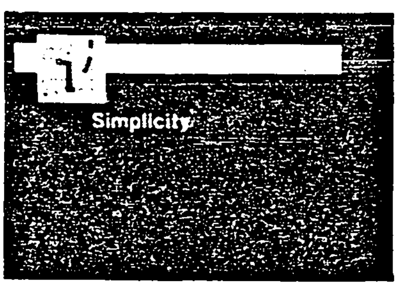

This forecast shows that the population of 200,000 with piped water inside has a per capita consumption of 160 liters per day. This group, then, is expected to require 32,000 cubic meters per day. The second group is the population of 10,000 with piped water outside. It is expected that this group will consume 20 liters per capita per day, totaling 200 cubic meters per day. When the consumption projections for both groups are added, the result is a total consumption requirement of 32,200 cubic meters per day.

131.



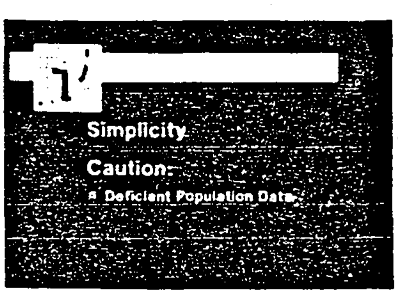

After the consumption forecast is prepared, the next step is to forecast the supply that will be required to meet consumption. In order to forecast supply, the consumption forecast is divided by one minus the share of unaccounted water (excluding standpipe consumption). In this example, the consumption forecast was 32,200 cubic meters per day and unaccounted water was estimated at 33 percent. The total supply forecast, then, is 48,000 cubic meters per day.

132.

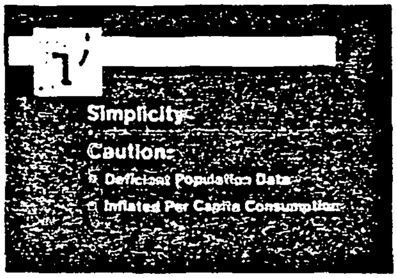



The primary advantage of using the requirements method to forecast demand is its simplicity. It is easy to use and to understand; therefore, it is widely used.

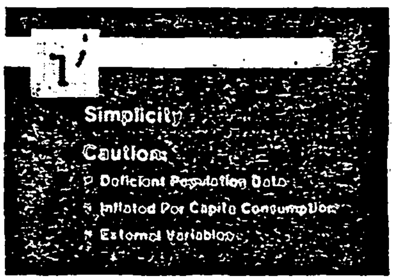
133.



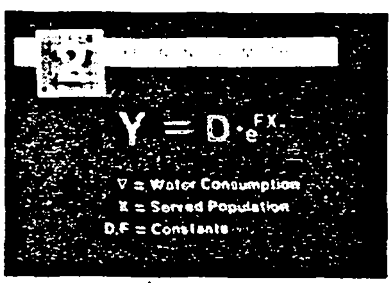

Caution should be exercised when using the requirements method. It is based on population data and these numbers are often artificially inflated. This can lead to overestimated demand.

134. 

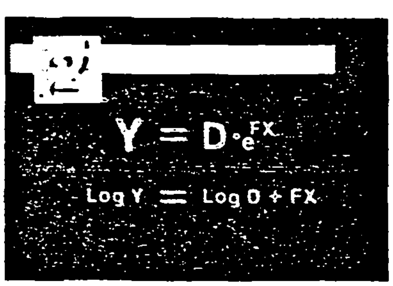

In addition, caution should be exercised because this method is also based on per capita consumption. These data are frequently inflated in forecasts.

135. 

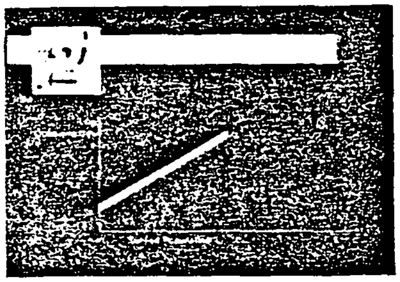

And third, population and per capita data are largely external variables that the utility cannot influence. This is particularly true with population figures that are also the most difficult to estimate exactly.

136. 

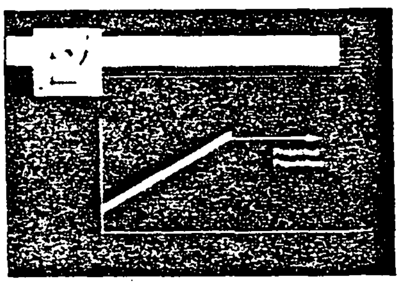

The second forecasting method we will review is the exponential method. The exponential method assumes that water consumption, Y, is an exponential function of the served population, represented by X. D and F are constants.

137. 

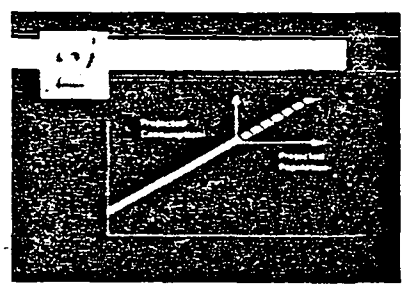

In order to construct a demand curve, using the exponential method, the first step is to take the logarithm of both sides. The result is the equation log Y equals log D plus F times X.

138. 

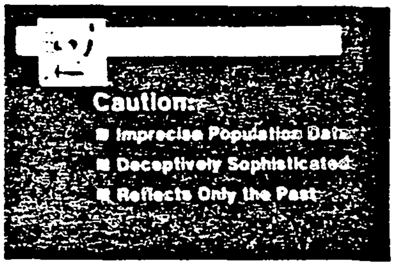
Then, water consumption, or Y, is plotted against the served population, X. On semilogarithmic paper, the result is a straight line like this one.

139. 

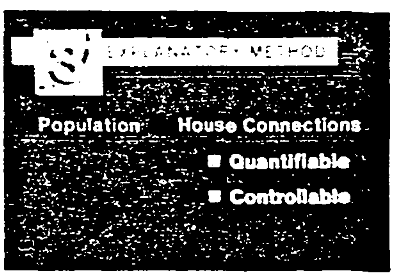
The next step is to project what the served population will number by a certain year.

140. 

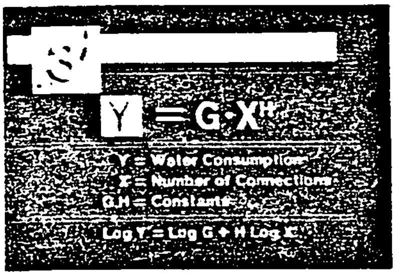
Projected consumption then is estimated by inferring future consumption levels from the historical data.

141. 

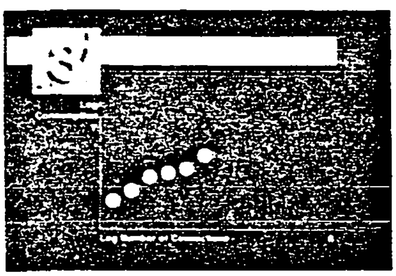

Like the requirements method, use of the exponential method also requires caution. It is based on population data which tend to be relatively imprecise. Second, using this method could also create a false sense of accuracy, because the method is more sophisticated mathematically. Third, the method primarily reflects the past. Future projections are merely extrapolated from the historical data.

142. 

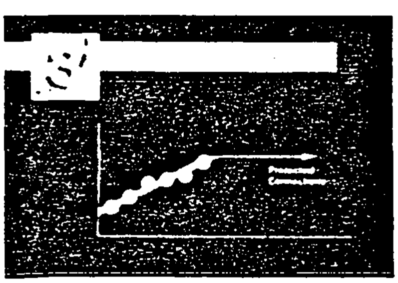

The third method of forecasting demand that we will review is the explanatory method. It differs from the other two methods because it is based on the numbers of house connections instead of population numbers. House connections are easier to quantify than population. Furthermore, the number of house connections in a community can be controlled, but population numbers cannot be controlled.

143. 

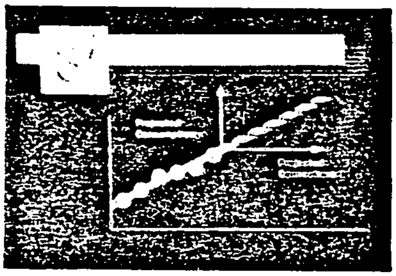

The explanatory method assumes that water consumption is a power function of the number of house connections. Y is the water consumption, X is the number of house connections and G and H are constants. In order to construct a demand curve using the explanatory method, first, we take the logarithm of both sides. The resulting equation is Log Y equals Log G plus H times Log X.

144. 

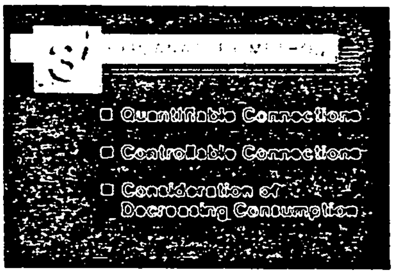
Consumption is plotted on the Y axis and numbers of house connections are plotted on the X axis. Then both variables are plotted in logarithmic scale.

145. 

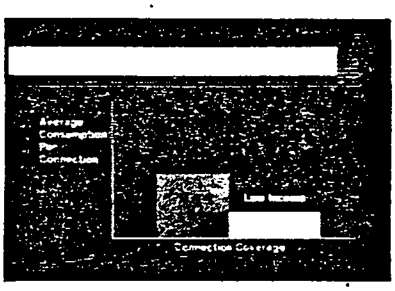
After plotting historical data on consumption and the number of connections, a straight line is drawn connecting the points. Next, the number of projected house connections is calculated for every year that will be included in the projection.

146. 

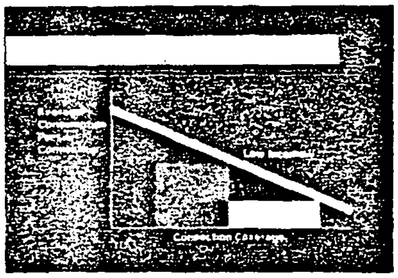
Last, projected consumption levels are calculated using the points on the line for the projected number of connections.

147. 

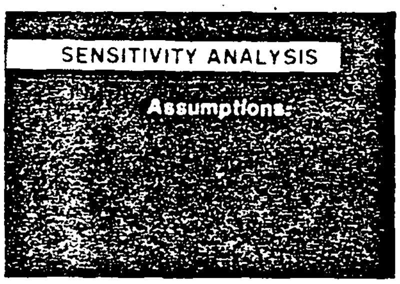

The explanatory method offers three advantages. First, it is based on numbers of house connections, which are easy to quantify. Second, the utility can determine the number of house connections and control them more easily than it can control population numbers. And third, this method takes into account the fact that average consumption per house connection decreases as the number of house connections increases.

148. 

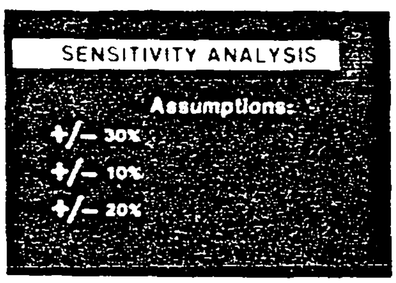

There are several reasons why average consumption per connection decreases as connection coverage increases. The first households connected tend to be in the high income group. Unconnected households often draw water from those with connections. This increases average consumption.

149. 

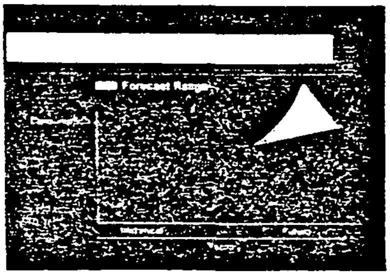
Later, when more low income households are finally connected, the number of connections is higher. At the same time, the average consumption per connection will decrease.

150. 

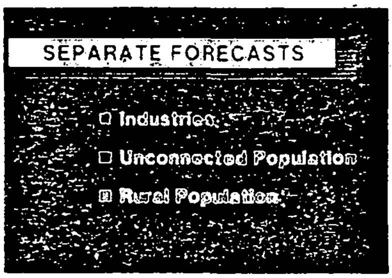

Regardless of which of the three projection methods is used, it is important to apply sensitivity analysis to the results. Sensitivity analysis is a technique to test what will happen if there are changes to the assumptions on which forecasts are based. Three important areas to apply sensitivity analysis are population numbers, numbers of house connections and per capita consumption.

151. 

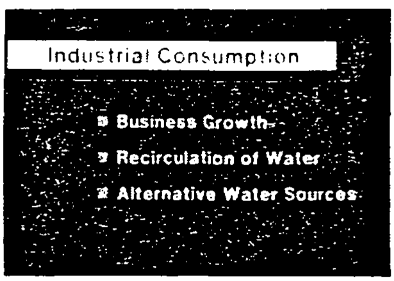

For instance, actual numbers of the population served may deviate from assumed levels by 30%. Or, the number of house connections could vary 10% from estimated numbers. In addition, per capita consumption could actually be 20% higher or lower than the estimates report. Any of these variances could affect the accuracy of forecasts.

152. 

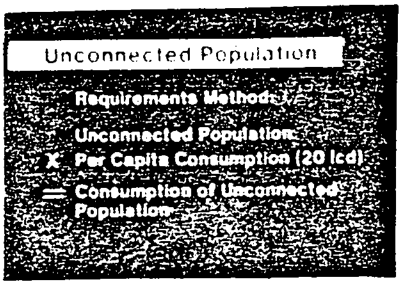
Because the assumptions on which forecasts are based may change, it is best to prepare a range of forecasts. This will help to make the final forecast as accurate as possible. More accurate forecasts will also help in planning project investments and financing more realistically.

153. 

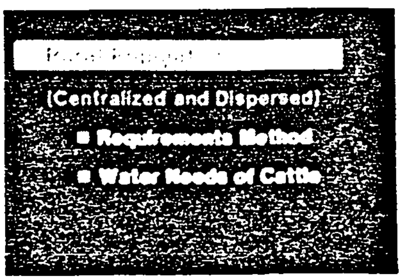

There are three groups whose demand or consumption should be projected separately from the population with connections. They are industries, the unconnected population and the rural population.

154. 

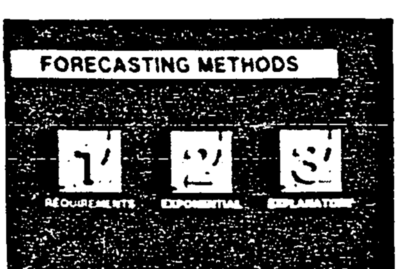

Industrial demand is usually projected on a case by case basis. Very large industrial consumers are few in number but account for a great share of total consumption. Where possible, projections of their demand should take into account expected business growth, possibilities for water recirculation and potential reliance on alternative water sources.

155. 

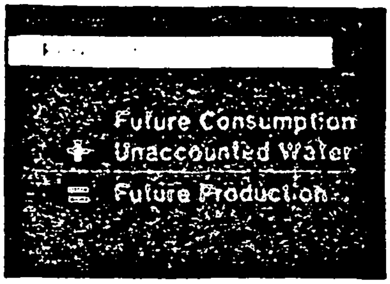

The consumption of a second group, the unconnected population, is also projected separately, usually using the requirements method. In this case, population numbers are multiplied by per capita consumption. The result is typically an adjustment to the forecast of approximately 20 liters per day.

156. 

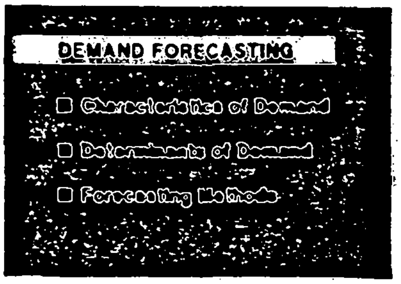

The third group to forecast separately is the rural population, including the centralized village population and the dispersed population. These groups' consumption is usually projected using the requirements method. In some rural areas, each head of cattle consumes double the amount each person consumes, approximately 40 liters per capita per day. In this case, the consumption by cattle would be added to forecasts of human consumption.

157. 

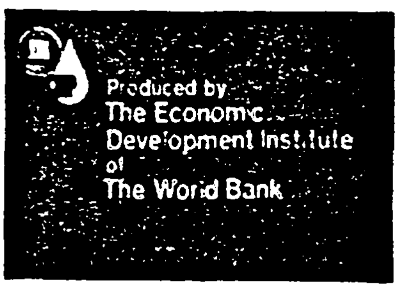

In summary, these three forecasting methods take into account several important variables that influence future water supply requirements.

158. 


The variables include the estimates of future consumption based on current and historical data plus the levels of unaccounted water.

159. 


Forecasts that are based on an understanding of the characteristics and determinants of demand will provide the important information needed to plan and select projects that can meet the community's needs.

160. 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