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THE RESIDENTIAL DEMAND FOR WATER AND SEWERAGE SERVICE IN DEVELOPING COUNTRIES: A CASE STUDY OF NAIROBI

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The Residential Demand for Water and Sewerage Service in Developing Countries: A Case Study of Nairobi

by

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April 7, 1977

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RESIDENTIAL DEMAND FOR WATER AND SEWERAGE SERVICE IN DEVELOPING COUNTRIES: A CASE STUDY OF NAIROBI

By: L. Kenneth Hubbell

I. Introduction

Literature on the residential demand for water is scant at best. Less than a score of studies by economists are found on the subject. The bulk of the research has been conducted by engineers and public administrators who followed the generally accepted "requirements" approach (Warford, 1966) for residential water demand forecasting and systems design. The pitfalls of this technique are catalogued in Hirshleifer, et al. (1969), and will not be elaborated on here, except to state that the method tends to overestimate future demand which in turn can cause utilities to overinvest in water supply systems.

Most of the empirical research on water demand, excluding that which has employed the "requirements" approach, has produced single-equation demand models derived from regression analysis. While not theoretically elegant from the economist's vantage point, these models represent a marked improvement over the previous methods of demand analysis. Actually, a chronological examination of water

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1The research for this paper was carried out as part of a larger study by the I.B.R.D. examining the question of the pricing of public utility services in developing countries.

2The most common technique followed consists of determining present per-capita consumption without regard to price or other variables, and multiplying this figure by estimated future population.
demand studies shows that such studies have progressively enhanced
our understanding of the factors influencing demand through more
sophisticated techniques of analysis, better data bases, and im-
proved treatment of results.

Previous studies of the demand for water, particularly the
estimated price and income elasticities of demand, are surveyed in
Wong (1972). As he notes, most of these studies have been little
more than cross-sectional appraisals of the consumption of water
by households in different communities. The number of communities
included and the type of charging systems employed vary considerably
from study to study. Moreover, with one exception only North Ameri-
can communities have been examined. There are a few studies though
that have estimated the price-quantity relationship from time-
series (T-S) analysis (see Headley, 1963; Wong, 1972; Pope, Stepp
and Lytle, 1975).

Wong's article indicated that a wide range of price and in-
come elasticities have been observed by previous investigators.
The income elasticity measure, for example, ranges from a low of
.28 (Gottlieb, 1963) to a high of 1.03 (Wong, 1972). For price,
the spread in calculated values is even greater. Howe and Lina-
weaver (1967) find the price response to be in the range of -.21
to -.23, while Gottlieb estimates the measure to be from -.66 to
-1.24.
Naturally, the wide dispersion of elasticity coefficients for the same commodity generates some doubt as to the accuracy of such findings. Several possible explanations have been offered for such divergent results. First, as suggested from above, the cross-sectional method followed in the majority of the studies has observed price differences rather than price changes. What is implied by this approach is that if user C consumes quantity $Z$ of water at price $Y$, while user D consumes quantity $Z'$ at price $Y'$, user C will consume quantity $Z''$ at price $Y'$. Needless to say, the implied conclusion of C's consumption of water at price $Y'$ does not necessarily follow from the previous propositions. Second, as pointed out by Wong (1972) and others, many of the investigators have for a variety of reasons found it necessary to employ water production rather than consumption data. When this occurs, the elasticity estimates tend to be biased because leakages from the system are not properly accounted for being treated as purchases, and because per capita residential demand estimate based upon aggregate urban water usage data lump together the residential, industrial, and public demands for water. Finally, in many cases researchers have been forced to use socio-economic data gathered from secondary sources in order to estimate various household-related variables in their regression models.

While the studies on residential demand for water are rather limited, and as just shown suffer from a number of short-comings,
only two studies have been undertaken in less developed countries, Meroz (1968), and Katzman (1975). Katzman in a random stratified sample of approximately 1400 households in Penang, Malaysia found both the price and income elasticity measures relatively inelastic. From cross-sectional data, the income statistic is estimated to be .30 to .39; and from a time-series analysis of a sub-sample of households, price is indicated to be highly inelastic, -.01 to -.02. Similar results were recorded by Meroz (1968) in his study of urban water demand across cities in developing countries. The specific coefficients determined were -.40 for price elasticity of demand and .40 for the income elasticity of demand. While both authors caution that their findings should be treated as tentative, the elasticity measures calculated in the two studies are very similar.

The purpose of this paper is to shed some additional light on the rather neglected empirical question of the demand for water and sewerage service in LDCs through a case study of the demand for this service in Nairobi. With reference to Nairobi, three specific questions are investigated: (1) is the demand for water and sewerage service responsive or unresponsive to income differences; (2) is site value a good proxy for income when estimating residential water demand; (3) is the price elasticity of demand for water and sewerage service relatively elastic (close to zero), moderately elastic (near one), or very elastic (greater than one). To answer these three questions the remaining part of the paper is organized
as follows: (1) The next section contains a description of the particular regression model examined in the case of Nairobi; (2) section three outlines the empirical results of the regression model; (3) the final section briefly examines some of the policy implications of the Nairobi study.

II. Specification of the Model

A. Data

Geographically, Nairobi is located 87 miles south of the equator, some 300 miles west of the Indian Ocean, and is just over a mile above sea level. In 1975 the city encompassed 226 square miles and had a population of approximately 730,000. Climatically, the city has no real winter or summer. For the greater part of the year the days are sunny and the nights cool and pleasant. A period of what is referred to as "long rains" occurs from March through May and a period of so-called "short rains" occurs from the end of October until the middle of December. Between these two periods is a dry season lasting from July through September.

Data for the demand analysis came from a stratified cross-sectional sample of approximately 400 households in Nairobi. After reviewing the data for various errors, the number of usable observations were reduced to approximately 230. Household water consumption and billing information was obtained for a three-month period, July through September, and for the two years, 1974 and
1975. As noted above, the months selected closely correspond to the summer or dry period. Owing to the different billing cycles (number of days) in each month, it was necessary to average three billing periods for each of the 230 observations in order to obtain comparable consumption data across households in the city.

As stated above, the study employs cross-sectional data. In particular, households included in the survey were randomly drawn from eleven pre-selected, representative neighborhoods. Estates selected cover the entire income range in Nairobi from the highest to the lowest, and the sample number chosen from the sample estates is roughly proportional to the city's population in each income group. By combining data from several sources, the following information was obtained for each household:

\[ \text{Data were also collected for the three-month period April through June, the so-called wet season. A comparison of the meteorological information between the two sample years, however showed that the amount and distribution of precipitation varied significantly in the two calendar periods. Hence, the above period was excluded from the demand analysis.} \]

\[ \text{Estates selected as representative neighborhoods were done so based on the data furnished in the 1970 Nairobi Household Survey. All the areas selected were indicated to be very homogenous from the standpoint of socio-economic characteristics.} \]

\[ \text{Site value in 1970 prices, and site sizes for the individual users were furnished by the Valuer's Office of the City of Nairobi. Household consumption figures, water charges and sewer charges, when applicable, were drawn from the records of the Nairobi Municipal Water Department. Ethnic group was judged from the surname on the account. All other data shown come from the 1970 Nairobi Household Survey. What is implicitly assumed by applying the socio-economic data of the Household Survey to the individual users in each of the water survey estates is that both samples were randomly drawn, and the means of the two do not differ significantly from the true mean for the area. No fewer than twenty-five observations were taken from any one sample estate.} \]
ethnic group (Africa, India, White) (E)

household consumption (liters per month) (Q)

household water charge (shillings per 1,000 liters consumed) (Pw)

household sewer charge (shillings per 1,000 liters of water consumed) (Ps)

site value of land (shillings per plot) (Sv)

site area (acres) (Sa)

average family size (number) (F)

average household income (1970) by ethnic group for sample neighborhoods (shillings per month) (Y)

All consumers in the study are metered and are connected to municipal water service, but not all are tied into the public sewer system. Septic tanks are used by those not on public sewers, and for the most part they are to be found in the wealthier housing estates. In terms of the survey, about 20 percent of the households sampled have septic tanks.

6 A few Nairobi households also use conservancy tanks for waste water removal. None of the households selected in the random sample, however, made use of this system.
Table 1

Nairobi Water and Sewerage Tariff Structure:
1974 and 1975

<table>
<thead>
<tr>
<th>Type of User</th>
<th>1974</th>
<th>1975</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-sewered</td>
<td>minimum charge;</td>
<td>Price per</td>
</tr>
<tr>
<td></td>
<td>8 shillings flat</td>
<td>1,000 liters</td>
</tr>
<tr>
<td></td>
<td>rate for consump-</td>
<td>1.43 shillings</td>
</tr>
<tr>
<td></td>
<td>tion less than</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,000 liters</td>
<td></td>
</tr>
<tr>
<td>Sewered</td>
<td>minimum charge;</td>
<td>2.2 shillings</td>
</tr>
<tr>
<td></td>
<td>8.5 shillings flat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rate for consump-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tion less than</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11,000 liters</td>
<td></td>
</tr>
</tbody>
</table>

Consumers are divided by the Water Department into five user categories: domestic, commercial, industrial, Nairobi City Council and Central Government. Above the required minimum level of 5,000 liters, all classes of consumers are charged the same rate per 1,000 units for water. Sewer charges, on the other hand, are not uniform across categories, but in general vary with the volume of effluent placed in the system by the user.

Source: Tariff Schedules of Nairobi City Council
In Nairobi every household as well as other users above some minimum level pay the same price per 1,000 units for water, regardless of the quantity consumed. As depicted in Table 1, under the 1974 tariff structure non-sewered users were billed at 1.43 shillings per 1,000 liters; in 1975 those same consumers paid 1.76 shillings per 1,000 units. In both years, however, users were subject to a minimum charge of 8 shillings if the quantity consumed during the month fell below 5,000 liters. Hence given the amount of the minimum consumption charge, actually applicable until monthly consumption reached 5,000 liters.

Households connected to public sewers, while liable to the same water tariff schedule as the non-sewered users, are charged an additional fee for waste-water disposal. The charge per 1,000 liters in 1974 was .77 shillings, but it was raised to .88 shillings in 1975. Like non-sewered consumers, those using public waste-water removal are also confronted with a minimum charge. Households are billed a flat fee of 8.5 shillings when their monthly water consumption is less than 11,000 liters. The combined charges, then, for sewered households in 1974 were 2.2 shillings per 1,000 liters (1.43 for water, .77 for sewers). Under the 1975 schedule the two charges totaled 2.64 shillings per 1,000 units (1.76 for water and .88 for sewers). To summarize the price changes shown in Table 1, sewered consumers in nominal terms underwent a 23 percent increase, while non-sewered households experienced a 19 per-

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In 1974, a shilling is approximately equivalent to $.18 U.S.
cent rise from 1974 to 1975.

It is clear from the foregoing tariff information that above some monthly minimum level of consumption, just four levels of price were observed in Nairobi—two rates for sewered and two rates for non-sewered residents. The two groups of consumers are combined in the Nairobi study, although it may be argued on theoretical grounds that separate demand estimations should be made for each type of service. No doubt there is some validity to this position. In defense of combining the groups, however, it can be argued that one of the most important factors influencing the consumption of water in LDCs is the ability to dispose of waste-water. If disposal is not constrained, there is a further basis for lumping the users together. This argument is of course subject to the additional condition that the two types of consumers do not have vastly different waste-water removal costs. That is to say, one group cannot dispose of its waste free, in a nearby stream for example, while the other must pay for sewerage service. This situation most likely does not exist in Nairobi; waste-water removal costs between sewered and non-sewered consumers are probably not that different, since the latter group must bear the construction expense of a septic tank system and annual pumping costs. There is quite obviously a difference in the time rate of payment between the two groups.

Ideally, what is needed is an estimate of the cost per 1,000
units of waste-water removal for both sewered and non-sewered users. To obtain this figure the expected life and total cost of the septic tank system must be known. But even if this information were available, there would still be the question of possible differences in the quality of waste-water disposal under the alternative systems. An estimate of the magnitude of any price differential which might exist in the removal of waste must be side-stepped for the present. 

B. The Demand Equation

A large number of mathematical forms of the residential demand equation were estimated, and the log-linear form was selected as the best single equation model. The particular expression for demand obtained through least squares multiple regression analysis is:

\[ Q = B_1 + B_2 P + B_3 Y + e \quad (1) \]

where all variables are in logarithmic form, and:

- \( Q \) = average monthly consumption
- \( Y \) = average household income
- \( P \) = average price \((P_w + P_s)\) of water and sewerage service

\(^9\)Prices for water and sewer services are expressed in nominal terms and were determined from customer billings. Both price \((p)\) and income \((Y)\) are deflated in the regression model. An index of 1.10, which is an estimate of the rise in the consumer price index from 1974 to 1975, was chosen. The regression results from the pooled, cross-sectional analysis are identical whether data are expressed in real or nominal terms.
\[ P \text{ = a disturbance term} \]

As equation (1) shows, three of six independent variables listed under (A) above, E, F and Sa did not enter the final form of the demand equation in the Nairobi study.\(^{10}\)

The fact that ethnic origin (E) is not a significant variable in the final expression was somewhat surprising. It was hypothesized that usage would be positively correlated with E; i.e., a higher level of consumption is associated with the Asian and European groups than with the African population. Such a relationship was anticipated because it was thought the former two groups had most likely acquired a larger stock of water consuming appliances than the latter. One possible reason for its failure to enter the regression equation is the anticipated effects of this variable were by and large captured by the income variable.

Family size, a common variable in water demand studies is significant in several of the single equation models examined. But as one might expect, the variable itself is positively correlated with Y. It was decided to omit F from the final form of the equation for this reason and because its inclusion had almost no effect on the estimated coefficients of the other variables. In

\(^{10}\) The significant variables were identified through step-wise regression analysis. Given the sample size, variables were excluded if they were not significant at the .10 level of confidence.
addition, the partial regression coefficient associated with F was quite low.

Site size, included to capture the effect of lawn sprinkling on households consumption, turned out to be insignificant. This result at first glance is unexpected since lawn sprinkling is thought to be a significant determinant of water usage (Howe and Linaweaver, 1967). In this study, the effect of this variable on consumption is no doubt neutralized by the way the regression model is formulated. By comparing the same three months in 1974 and 1975, the seasonality factor, which accounts for most of the variations in lawn sprinkling demand, is basically removed from the analysis. Since the major purpose of the study is to calculate the price and income elasticities of demand for water, the latter regression formulation was followed to limit seasonal influences upon demand.

The variable $S_v$, while missing from equation (1), is found to be significant but is excluded because the variable turns out to be an excellent proxy for income. The two measures are highly correlated and may therefore not be used in the same regression equation. As demonstrated in the next section, when $S_v$ is substituted for $Y$ in equation (1) the value of the estimated coefficients are only slightly different.

Since the demand expression is in log-linear form, the estimated coefficients are equal to the elasticities of demand. In
addition, as Halvorsen (1975, p. 12) has demonstrated, when the
demand equation is log-linear, the elasticities of demand estimat-
ed with average price data are equal to those that would have been
obtained with marginal price data. Finally, if water is a normal
good, which it is, the coefficients of P should be negative and
the coefficient of variables Y and Sv should be positive.

III. Empirical Results

Coefficients of the variables shown in (1) were estimated from
the data sources outlined in the previous section. But for reasons
which will be stated below, the individual household observations
were grouped by income bracket, and the number of observations re-
duced to twenty-three (23) before estimating the demand statistics.
New data points for consumption, price, income and site value were
calculated as follows: consumers in each year were divided into
one of ten identified income brackets; within each income class
they were further segregated into sewer and non-sewered users;
based on the observations in each class an average consumption,
price, income and site value figure was calculated.¹¹

¹¹To ensure that the price-quantity relationships observed
yield a uniquely identified demand curve and do not reflect a mix-
ture of supply and demand responses, minimum consumption households
are omitted from the data site. Their exclusion means, that for
those with consumption in excess of 5,000 liters in the case of
non-sewered households and 11,000 liters for sewered ones, the
price variable equals the marginal charge for the service. Thus
the consumption response of households to price charge is directly
observed.
To avoid biasing the regression results, the twenty-three data points of the new data set were weighted by the percent of households, in Nairobi in each of the designated consumer classes.

The decision to use average household data by income class in the regression model is predicated on two factors: First, the price variable and \( Q \) are inversely related, because the dependent consumption variable is determined from the billing records of the households. This relationship exists because price is calculated from dividing the monthly household bill by \( Q \). Second, and perhaps more important, since the income statistic associated with the sampled users is an average figure for a neighborhood and not the actual income statistic for the selected household, logically the price and quantity variable should be expressed as a neighborhood average when estimating the elasticity coefficients.

A. Model 1:

Results for equation (1) are:

\[
Q = 3.61 - .48P + .36Y \quad (2) \quad R^2 = .66 \\
(t=47.6) \quad (t=8.3) \quad (t=12.7)
\]

where \( Q \) is the demand equation for the dry period (July, August and September). In equation (2) the variables \( P \) and \( Y \) have the anticipated sign, and the estimated own-price elasticity and income statistic are both shown to be relatively inelastic.
Unless specified differently, all variables are significant at the .01 level. While not shown, the average residential consumption per household per month in (2) was 33.6 liters for 1974 and 36.8 liters for 1975.

As suggested in the rate structure discussion, the pooled cross-sectional approach was necessitated by the data base. One advantage of this approach is that the elasticity measures derived from the analysis reflect long-run adjustments. In general, the C-S approach considers the individual moving up the income distribution scale and adjusting to the consumption habits of the higher income groups as he moves to succeedingly higher income brackets. In the case of Nairobi, with regard to this assumption of C-S analysis two words of caution need to be interjected. First, the assumption that households in the lower income brackets adopt the consumption

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12 Individual regression equation were also estimated for the July through September period in 1974 and 1975. The beta coefficients of the price and income variables in the 1974 expression were only found to be significant at the .27 level, hence the results were judged not to be significantly different from zero based on an acceptable confidence level of .10. The 1975 expression, on the other hand, yielded the following results:

\[ Q_{75} = 3.78 - .68P + .47Y \quad R^2 = .86 \]
\[ t = 40.7 \quad (t = -6.1) \quad (t = 17.8) \]

The pooled cross-sectional model (2) above is judged to be a superior estimating expression however, since the single year regression has just two price observations compared to four in the pooled case.

13 See Tables II and III in the Appendix for further data on average consumption per household by income class gathered from sampled households.
habits of the upper income brackets as their income increases may not strictly apply in Nairobi. Distorted results may occur because the population is not homogenous ethnically across income classes. That is to say, 'the wealthier portion of the population (also housing estates) is largely European and Asian and both groups may have water consumption pattern that differ from the African population in the city. The failure of the ethnic (E) variable to enter as a significant variable in equation (1), however suggest this is not a serious problem in the present study.

Before leaving this section, let us compare the results of equation (2) with some of the investigations cited previously. Surprisingly, on the whole the results fall within the range of the earlier cross-sectional residential studies even though, as pointed out, they for the most part applied to water demand analysis in developed countries. For example, the price and income elasticities of the present analysis are very close to the results obtained in the celebrated article by Howe and Linaweaver (1967, p.25) for residents in ten areas in western states. They estimated the price and income relations for residents with metered service and those connected to public sewers to be -.70 and .43 respectively. While the approaches are quite dissimilar, the results of Meroz (1968) and the Nairobi study are indeed very close. His price and income elasticity coefficients, which were computed from a cross-sectional analysis of urban water demand in several LDCs, were -.4 and +.4 respectively.

B. Model 2:

The regression results when site value is substituted for in-
come in equation (2) is shown below. The calculated coefficients of equation (3) are similar to those obtained previously in (2).

\[ Q = 2.94 - 0.49P + 0.28Sv \]  
\[ R^2 = 0.75 \]  
\[ (t=27.1) \quad (t=-9.7) \quad (t=13.3) \]

Like equation (2) in section A, the price and site value variables have the proper signs, and all variables are significant at the .01 level.

The estimated price elasticity measure for (3) is inelastic and very close to the statistic determined in equation (2). Both statistics suggest a moderate response on the part of consumers to a change in water prices, but the site value coefficient of (3) is relatively more inelastic than the income relation determined in equation (2). For all practical purposes, however, the conclusions to be drawn from the two equations are identical; household consumption is relatively unresponsive to changes in either site value or income.

IV. Concluding Remarks

Like many of the earlier demand studies, the current model was hampered by data deficiencies. In particular, certain socio-economic data concerning consumers within sample neighborhoods was obtained from a government survey which had been conducted for another purpose. Further, the lack of reliable consumption information over an extended period of time required the data base to be truncated to the two-year period studied. In view of these and other limitations, no attempt was made to develop a model based on con-
sumer theory. Instead, a more modest and practical approach was taken, whereby a simple demand equation was estimated from regression analysis. Specifically, answers to three rather general questions were sought:

(1) Is the demand for water and sewerage service relatively unresponsive to price change (close to zero), moderately responsive (near 1), or very responsive (greater than 1).

(2) Is the income elasticity of demand for public water and sewer service near zero (relatively inelastic), near one (unitary), or near 2 (relatively elastic).

(3) Is site value a reasonable proxy for income when estimating a demand expression for water and sewerage services.

Briefly restating the results of the simple model (equation 2), the coefficient for price is found to be -.48 which indicates that consumption is moderately responsive to price changes. From the same expression the coefficient for income, is estimated as .36, which suggests that this variable is also relatively inelastic. Since these estimates are based on average consumption, price, and income data, the coefficients should be interpreted as average elasticity measures. Furthermore, since the elasticities calculated for price and income are based on pooled cross-sectional data, the statistics are a mixture of short-run (time-series) and long-run (cross-sectional) measures of elasticity.

These results have important policy implications for public
utility authorities in the developing countries. First, they sug-
gest that consumers in LDCs do respond to price changes. This is 
a particularly significant finding in the case of LDCs, although 
the implications hold equally as well for utilities in developed 
countries. If there is little difference between the long-run and 
short-run price elasticities, it implies that price to some extent 
can be used to curtail household consumption when existing capacity 
is strained. Care should be exercised, however, when price is used 
as a rationing device in LDCs. An increase in the tariff structure 
for example, given the maldistribution of income that exists in LDCs, 
has unavoidable equity implications which public officials or reg-
ulatary boards can not entirely overlook.

In addition to the above, the elasticity relation also suggests 
that in the long-run price should not be ignored when water demand 
is projected. More specifically, it implies that if the require-
ments approach to demand analysis is employed to forcast demand, in 
all probability the projected increment to capacity will be larger 
than actually needed at the time. If followed, the close to zero 
elasticity assumption of the requirements approach, would result in 
over investment in public water supply luxury that local govern-
ments can ill afford.

Another policy implication to be drawn from the results re-
lates to the question of the cross-subsidization of poorer segments 
of the community by the wealthier ones. Such a policy is often re-
commended because of the extremely low incomes of the urban poor in most LDCs, and the realization that these poorer residents cannot gain access to water and sewerage service without some type of subsidy (Hubbell, 1976). From the evidence obtained in the Nairobi study, the scope for cross-subsidization of service within the community looks promising. Clearly, though, more work needs to be done in this area before the feasibility and the specific form of assistance to the poor can be judged. In order to render such a judgment, specific information is required on how both the price and income elasticities of demand vary among income classes. Unfortunately, the current study was not able to isolate these relationships.

Finally, it was observed that in the case of Nairobi land value serves as an excellent proxy for income in the regression model. Although not a completely unexpected result, it is noteworthy. Site value or property value data are normally available in LDCs and the substitutability of this proxy variable may prove useful when income cannot be obtained without considerable difficulty or cost, or both. Of course, the extent to which the variables are interchangeable in such studies will vary from city to city, depending upon the type of property or site valuation, and the reliability of the data for such purposes. One should in most cases be able to make a judgment about the suitability of cadastral information for demand estimating purposes after consultation with local officials and a review of local records and procedures.
Appendix
### TABLE II

**Water Consumption by Income Class**

(Average Consumption per month 1,000 liters)

<table>
<thead>
<tr>
<th>Income Classes</th>
<th>July, August and September</th>
<th>April, May and June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Consumption</td>
<td>Average Consumption</td>
</tr>
<tr>
<td>month</td>
<td>Sewered</td>
<td>Non-sewered</td>
</tr>
<tr>
<td>less than 400</td>
<td>21.6</td>
<td>10.5</td>
</tr>
<tr>
<td>400 to 599</td>
<td>11.5</td>
<td>9.0</td>
</tr>
<tr>
<td>600 to 899</td>
<td>8.4</td>
<td>8.8</td>
</tr>
<tr>
<td>900 to 1399</td>
<td>25.2</td>
<td>23.8</td>
</tr>
<tr>
<td>1400 to 1749</td>
<td>26.4</td>
<td>30.0</td>
</tr>
<tr>
<td>1750 to 1999</td>
<td>30.0</td>
<td>65.7</td>
</tr>
<tr>
<td>2000 to 2349</td>
<td>31.8</td>
<td>31.6</td>
</tr>
<tr>
<td>2350 to 2499</td>
<td>37.9</td>
<td>21.6</td>
</tr>
<tr>
<td>2500 to 3100</td>
<td>57.9</td>
<td>21.6</td>
</tr>
<tr>
<td>Over 3100</td>
<td>44.9</td>
<td>51.5</td>
</tr>
</tbody>
</table>

**Average Quantity per Household (sewered plus non-sewered)**

- 1974: 24.9
- 1975: 28.8

**Total Amount per month**

- 1974: 5,805
- 1975: 6,947

**Source:** Sample data of 230 Nairobi Households in 1974 and 1975.
### TABLE III

**Water Consumption by Income Class for Households Above the Required Minimum**

(Average Consumption per Month 1,000 liters)

<table>
<thead>
<tr>
<th>Income Classes (Shillings per month)</th>
<th>July, August, September</th>
<th>April, May and June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sewered</td>
<td>Non-Sewered</td>
</tr>
<tr>
<td>less than 400</td>
<td>28.4</td>
<td>14.6</td>
</tr>
<tr>
<td>400 to 599</td>
<td>18.9</td>
<td>14.3</td>
</tr>
<tr>
<td>600 to 899</td>
<td>12.3</td>
<td>15.2</td>
</tr>
<tr>
<td>900 to 1399</td>
<td>27.2</td>
<td>30.6</td>
</tr>
<tr>
<td>1400 to 1740</td>
<td>26.4</td>
<td>28.7</td>
</tr>
<tr>
<td>1750 to 1999</td>
<td>30.0</td>
<td>35.8</td>
</tr>
<tr>
<td>2000 to 2349</td>
<td>31.4</td>
<td>27.1</td>
</tr>
<tr>
<td>2350 to 2499</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2500 to 3100</td>
<td>44.0</td>
<td>29.9</td>
</tr>
<tr>
<td>Over 3100</td>
<td>47.3</td>
<td>37.3</td>
</tr>
<tr>
<td><strong>Average Quantity per household</strong></td>
<td>33.5</td>
<td>36.8</td>
</tr>
<tr>
<td><em>(sewered plus non-sewered)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Amount per month</strong></td>
<td>5,234</td>
<td>6,515</td>
</tr>
</tbody>
</table>

*Source: Sample data of 230 Nairobi Households in 1974 and 1975*
REFERENCES


