RESEARCH ARTICLE

Coping with poor water services and the demand for change in Trinidad and Tobago

Kameel Virjee[a] and Susan J. Gaskin[b*]

[a]Financial Specialist, Water and Sanitation Program – Africa, World Bank, Nairobi, Kenya;[b] Associate Professor, Civil Engineering and Applied Mechanics, McGill University, Montreal, Canada

Abstract

Trinidad and Tobago's 1.3 million residents are provided water supply and sewerage services by a national utility, whose service levels have been inadequate and deteriorating through the recent past, largely due to a lack of investment in utility infrastructure. A willingness to pay study assessed the degree of coverage and quality of service and the residents' willingness to accept water tariff increases for an increase in service level. Willingness to pay for change is low, below current tariffs, due to skepticism about the likelihood of change and due to the ability to cope with bad service through the pervasive use of local storage.

KEYWORDS: water demand, willingness to pay, contingent valuation, water tariffs, local storage.

*Corresponding author. Email: susan.gaskin@mcgill.ca

1   Introduction

Access to clean water supplies has considerable and immediate impacts on public health and longer term economic benefits to a household. Sustainable provision of clean water is of critical importance.

Trinidad and Tobago has 1.3 million residents in 340 000 households (Figure 1).   The Water and Sewerage Authority (WASA), formed in 1965 by an act of Parliament, is responsible for the expansion and maintenance of waterworks to supply all residential, commercial and industrial water demands, as well as for water resources management. WASA has been responsible for all waste water treatment facilities since 2004. Domestic users account for 36% of the total water abstracted, industry for 14% and agriculture for only 1% while the remaining 50% is unaccounted for water (WASA, 2002).

The utility and its management have traditionally been politicized. High government revenues due to high oil prices and the perceived inevitability of central government cash transfers allowed cost recovery by the utility to be of low priority (Virjee and Gaskin, 2003). The revenue base has decreased due to decreasing real rates over time as nominal water tariffs were only adjusted in 1937, 1986 and 1993 (WASA, 2008b), billing efficiency was low and the labour force was overly large (16 staff per 1000 connections, (Stiggers, 1999)). This resulted in insufficient funding (in 2006 the

expense to revenue ratio was 2.4:1(WASA, 2008a)) for investment in physical infrastructure and an under maintained, sub-optimal system.

WASA reports that 92% of the population has water services in the form of an in-house piped connection, a standpipe within 200m of their dwelling or free truck borne water. The spatial and temporal variation in reliability is increasing and was reported by WASA as a full service equivalent (FSE) of 77% for 2002. The FSE is a distribution network water availability weighting based on the planned schedule of service (Nankani, 1997). However insufficient knowledge of and management systems for the network combined with a lack of district and household metering means there is a high uncertainty in the FSE number.

Water supply is metered for about 70% of industrial and commercial customers. Domestic customers are unmetered with rates based on the annual taxable value (ATV) of the property with quarterly rates up to TT$ 304 (US$50) for an in-house connection and of TT$33.75 (US$5.55) for a standpipe user. Domestic users account for about 75% of the total number of connections and 35% of the total revenue for 36% of total water usage (two-thirds of the total delivered water).

The need to recover costs and invest in infrastructure at WASA is considerable. While results are contingent on effective management, it requires an increase in water tariffs. Increasingly it is recognized that users must be consulted for systems to be sustainable (e.g. Sara & Katz, 1998) and that analyzing consumers' preferences and perceptions (e.g. McPhail, 1993a) will increase the financial sustainability of utilities.

This paper discusses the results of a national survey which aimed to assess the current level of domestic water supply, wastewater and electricity service experienced by the residents of Trinidad and Tobago (Virjee, 2004). The survey aimed to ascertaining the willingness to pay (WTP) for changes in the level of service experienced by users. The WTP methodology used is discussed, as are similar applications in developing countries. The survey results for water supply services are presented and compared to the official coverage values, and coping strategies associated with inadequate supplies are discussed. An econometric analysis of the WTP bids for improvements to water services follows and finally the policy implications of the survey results are discussed.

2 Willingness to Pay and Contingent Valuation

In many developing country water supply systems service levels are poor or lacking. In attempting to upgrade existing systems, or implement new systems it is beneficial to understand consumer perceptions towards proposed changes. A component of this is their willingness to pay (WTP) for the change sufficient to ensure net positive benefits, which may include a non-captured public benefit. Earlier work has argued that a lack of information on the WTP of users has led to the slow expansion of services, or large inappropriate infrastructure poorly maintained due to deficient demand (World Bank Water Demand Research Team, 1993). The arbitrary maximum "five percent" (of income) rule has, in some cases, limited the appropriateness of the system and decreased its sustainability (e.g. Rabat (McPhail, 1993b)).

Most WTP studies for water supply and sanitation services in developing countries have employed the contingent valuation (CV) method, a stated preference technique, as it is recommended as reliable for WTP elicitation (e.g. Ardila et al., 1998). A multipart household survey presents the respondent with a hypothetical scenario describing the change to be valued using open-ended questions, bidding games, dichotomous choices or payment cards (Mitchell

and Carson, 1989). An early application evaluating the demand for improved water supplies in a project being installed by CARE in Haiti (Whittington et al., 1990) demonstrated that the CV method resulted in an understanding of the demands of users and in the design of a more appropriate system. A later large study with about 1200 respondents in rural villages in Pakistan (Altaf et al., 1992) demonstrated that the WTP of villagers surveyed was below the 5% of income rule of thumb often used in assessing affordability of service options. Briscoe et al (1990) demonstrate that WTP information can be integrated with policy analysis to determine rates which allow for cost recovery and protect poor sections of society. A persistent criticism of the method has been that users, due to the hypothetical nature of the proposed scenario, have no incentive to give honest answers. In a unique study, Griffin et al. (1995) revisit households in Kerela, India, and determined that 91% of actual decisions to connect to the system were predicted by the survey prior to system implementation. Whittington et al. (1998) show how analysis of CV data can be used to design demand responsive interventions by including significant minorities who are WTP considerably more than the average for upgraded private metered connections. Similarly, McPhail (1993a) shows the urban poor in Rabat are WTP for upgraded connections despite plentiful water available at a standpipe level of services.

3   Methods : Field Procedures

The current level of water supply services and the demand for changes to this service was assessed using a multi-part survey administered to a randomly selected national sample of 1419 households in May – June 2003 (Virjee, 2004). The questionnaire used had been developed through an iterative process with expert consultations and extensive pre-testing, which led to considerable revision of the initial draft document. The questionnaire contained multiple sections: a socio-economic section, a current level of service section and a contingent valuation section to understand the demand for change from the just described status quo. The contingent valuation scenario was the ideal level of service - in-house service with guaranteed 24 hour reliability of supply with an adequate water pressure and high bacteriological and aesthetic water quality -, which was set by WASA and the Regulated Industries Commission (RIC), the national utility regulator. This ideal scenario was offered to users with in-house piped supply and to those using lower levels of service. The service upgrades differed, as for the later group it included a service upgrade to an in-house piped connection. The ideal situation was of interest to the regulator as the government of the Republic of Trinidad and Tobago (GORTT) was aiming for 'developed country' status by 2020, 'vision 2020'. The demand for intermediate service levels was not examined, nor was the scenario designed with technical feasibility in mind.

A bidding game format (e.g. Randall, 1974) was used to elicit the maximum WTP for service level changes due to its simplicity, using the median current water bill for in-house connections as the starting point. The Central Statistical Office's (CSO) Continuous Sample Survey of Population (CSSP) sampling method was used to select 1419 households, using a two stage stratification scheme based on geography and labour force characteristics (CSO, 1989). The ideal basis for stratification, by water source used, was closed due to a lack of accurate data. The non-response rate was 12.5% and was due mainly to errors in the CSO supplied listing records and the difficulty in accessing some remote areas. The CSO provided a list of trained enumerators from which 30 were selected to administer the survey. The selected enumerators were trained extensively, using role plays and other methods, in the particulars of the methods used in this study. These enumerators were supervised by six trained supervisors.

4   Survey Results

4.1   Sample Characteristics

The proportion of female respondents (59%) was higher than male respondents, probably as most questionnaires were administered during the daytime when men were working out of the home. The measurement of the quality of service by respondents home during the day more accurately reflects the true level of service to the household. However, if these respondents are unemployed, the indicated WTP may not be completely representative. 80% of male and only 50% of female respondents were responsible for the water bill. Thus there may be a bias introduced through the gender bias in the sample. However, it is most likely that the female respondents, irrespective of bill payment responsibility, influence household budgeting and so would be reasonably able to assess their willingness to see and pay for changes to water services.

About 60% of households lived in owner occupied accommodation and almost 15% lived in housing with uncertain tenure, comparing well to prior CSO tenure profiles (e.g. CSO, 2002). The WASA Act does not allow the utility to connect properties to the network where there is uncertain tenure, forcing such households (squatters) to rely on, at most, utility supplied standpipe levels of service. The mean household income of the sample was TT$2900 (US$477) per month, which was similar to measures of income from formal wages in other studies (CSO, 2002). Table 1 provides a summary of the characteristics of the survey respondents.

4.2   Water supply service levels

The study characterized the sources of water used by households and respondents ranked their importance subjectively since they are unmetered. The primary water source for 83% of the sample was either an in-house piped connection or a standpipe. This compares unfavourably with the utility's reported rate of 92%. The discrepancy is most likely due to WASA's coverage being a measure of access to piped infrastructure with no adjustment for availability of water due to routine scheduling. Water scheduling leads to periods when users must switch to alternate water sources, which was the case for 27% of households. Rainwater harvesting was used by 16% of households. Table 2 shows the water sources used by respondents.

Access to improved water sources, as defined by WASA, includes standpipe users, with the standpipe at a maximum distance of 200m. Of those whose primary water source was a standpipe, 60% were further than the mandated 200m maximum distance and 20% were further than 800m from the closest standpipe. Thus further reducing measured access.

The reliability of the level of service was characterized as water availability in hours per week. Only 27% of the sample had water available for 24 hours seven days per week. While almost 30% of the sample received no water from WASA at all, during the time of the survey. Despite the significant degree of intermittency of service, over 60% of the respondents in this study indicated that they required no further water supply due to the prevalence of local storage facilities. 68% of respondents had water storage tanks on their premises with an average installed capacity of 610 gallons. As a result of these coping mechanisms, 82% of those with tanks had a 24 hour water supply. The effect of local storage is to directly facilitate 24hr water supplies for at least half of the sampled houses.

The consumption of unmetered domestic water customers was estimated from the number of days of supply provided for by the total installed water storage. For households where storage did not afford a permanent water source, the

average water consumption was 325 litres per capita per day. However, this estimate is depressed as households using stored supplies would ration their water use. This compares well to the 330 litres per capita per day of a 1991 a survey of 53 households having relatively reliable water supplies, not constrained by scheduling practices (Delcan International Corporation, 1992).

Wealthier households (earning over TT$ 5500 (US$905) per month) had better access to reliable water supplies than poorer households (earning less than TT$ 1500 (US$247) per month). Only 24% of poorer households had a 24 hour supply compared to almost 50% of wealthier households. Wealthier households also had access to in-house piped supplies more frequently than lower income households with 15% of poorer households relying upon standpipes as their primary water source compared to only 3% of wealthier households. Compounding the reduced service level to the poor due to the reliability bias discussed above was the affordability of coping mechanisms. Only 58% of poorer households had water storage tanks compared to 84% of wealthier households. The quality of service offered to the poor is much lower, in terms of reliability of water as well as the ease of access, as shown by the data in Table 3.

Generally respondents felt that the water quality was high, though there were some reports of low aesthetic parameters such as taste and colour. Standpipe users were more dissatisfied with water pressure due to the direct impact, in terms of queuing and waiting times. Those with piped connections are able to install tanks and pumps to circumvent poor pressure in the mains supply and so had higher levels of satisfaction.

Many water users in Trinidad and Tobago do not directly pay their water rates as it is either included in their rent or as they have uncertain housing tenure. Fifty-five percent of the sampled households directly pay their water rates, while 70% of the standpipe users and almost 30% of the in-house piped users were not responsible for their water rates. Standpipe users are often unaware of their responsibility to pay water rates, resulting in minor revenue loss to the utility as standpipe rates are low. About 10% of the sample depended upon non-utility suppliers for supplementary water supplies at an average amount of TT$ 640 (US$ 105 per quarter) or four times the average water bill in the survey.

5   Multivariate analysis of WTP bids

Multivariate logistic regression (logit model) was used to understand the measured WTP values. The probability that the improved option is chosen is a linear function of the characteristics of the household, the features of the option and a random error component, which includes uncertainty of the respondent and measurement error due to omitted variables.

Separate models, explaining the variance in the accepted contingent valuation bids, were calculated for customers dependent upon their water sources, as the water sources used require different coping mechanisms and attitudes, resulting in different preference functions. The first model, Prin-house, was constructed to explain preference structures of households depending upon an in-house connection exclusively, Eq. (1), the second, Prin-h+sec, is for those who in addition rely upon some secondary source, Eq. (2), and the third, Prno-in-h, for those whose primary source is some other water supply, Eq. (3),

$$\Pr_{in-house}(imp) = 0.003 - 0.009 PIS + 0.004 CB + 0.055 Inc - 0.201 TrW \qquad (1)$$

$$\text{Pr}_{in-h+\sec}(imp) = -0.453 - 0.009 PIS + 0.110 Inc + 0.458 TrW + 0.803 BR - 0.649 OCh \qquad (2)$$

$$\text{Pr}_{no-in-house}(imp) = -0.187 - 0.008 PIS + 0.141 Inc - 2.49 St + \alpha Age + \beta Loc \qquad (3)$$

where Pr (imp) is the probability that the improved option is chosen, PIS is the price of the improved supply (TT\$/quarter), CB is the current bill amount (TT\$/quarter), Inc is household income (1000TT\$/month), TrW indicates whether the household currently treats water (1-no;0-yes), BR is the number of bathrooms in the dwelling, OCh indicates whether the household incurs other water charges (1-no;0-yes), St is the fraction of the week that storage lasts, Age is the age group of the respondent (<20, 20-29, 30-39, 40-49, 50-59, >60), and ⊡Loc is the geographic location of the household (Port of Spain, San Fernando, Arima, rest of Trinidad, Tobago). The results of the logit models for the three different cases (Equations 1, 2 and 3) are summarized in Table 4. They are those with the highest level of model fit of the numerous variations in model specification tried.

The relative importance of the variables in determining WTP is obtained from an examination of the price elasticity of the WTP, summarized in Table 4. The price elasticity is defined as the percent change in WTP resulting from a 1 % change in a parameter (e.g. PIS, CB, Inc, St) and the quasi-elasticity is defined as the percent change in WTP resulting from a unitary change in a parameter (TrW, BR, OCh, Age, ⊡Loc). The percent change in WTP is based on the average quarterly water bill of the sample (TT\$155/quarter) and on the average values of the parameters for the sample (PIS = TT\$137/quarter, CB = TT\$155/quarter, Inc = TT\$2900/month, St = 0.28 weeks).

Across all models, household income is the most highly significant parameter in determining WTP and the only parameter that is elastic (Table 4). The positive income parameter implies that richer households are WTP more for the improvement offered. The WTP is higher for households with lower current service levels as indicated by the increase in the elasticity from 1.0 to 2.0 to 2.6 with decreasing current service level (Table 4). The price of the improved option has a marginal negative effect. Although it is highly significant in all three models, the average price elasticity of -0.007 (Table 4) indicates that households do not feel they can much reduce the quantity of water that they use even when the price increases. All other household parameters, which very across the models, are inelastic.

In model 1, for users whose exclusive supply is an in-house connection to WASA's network, households who currently treat their water at home, by boiling, bleaching, filtering or some other method, are WTP more than those who are not (elasticity of -0.12, Table 4). As the cost of most home treatment methods are characterized by relatively large variable costs and relatively small fixed costs, improvements in water quality result in immediate savings to the household. Variables describing the prevalence of storage facilities were not significant, likely as storage costs are fixed there are no financial benefits of increased reliability in the short term. The location variables were also not significant implying that the average WTP was similar for residents of rural and urban areas. Age was also not significant.

In model 2, households relying on in-house pipe supplies and a secondary source will pay more as their water needs increase, as the cost of water, in terms of time and inconvenience, increases with the use of multiple water sources. A crude measure of this water need is the number of bathrooms in the dwelling, and WTP increases with an increase in that metric (quasi-elasticity of 0.52, Table 4). Where households incur charges in addition to their water bill for their secondary source, for instance from a water tanker, they are willing to pay more than households whose secondary

source of water is free (quasi-elasticity of -0.42, Table 4). Again, this is reasonable given the immediate avoidance of expenditure associated with a service upgrade. The variable concerning treatment of water is again significant but positive with a quasi-elasticity of 0.33 (Table 4). It is likely that the costs of treating water is increased for users relying upon multiple water supplies, so the benefits of increased water quality are realised in the medium term. This is supported by the increased levels of dissatisfaction with water quality among users depending upon multiple water sources. Again, the presence of local storage does not affect the WTP. Age and geographic location, similarly, are not significant.

In model 3, for users who depend wholly on non-in-house piped water supplies, where houses can store sufficient water to meet their weekly water needs, their WTP for change is lower as the benefits associated with a more consistent supply have already been achieved through the installation of local storage. Age impacted upon WTP, with those between the ages of 30 and 50 being WTP significantly more than those under 20. This is most likely due a higher value placed on their time by those who most likely have families and work full time. In addition non-in-house piped users were WTP different amounts for service improvements depending upon their geographic location. Those in rural areas, suffering from distant standpipes and delays in truck borne water in times of shortage, would be WTP more to avoid the coping costs associated with a poor supply. As well the lack of reliability in San Fernando, the major city in the south of the Trinidad, increases its residents' WTP.

The preferences of respondents were related to the current levels of service as indicated by the different relevant specifications given by the three different model specifications. This conclusion is further supported as when the data was pooled and a single model estimated, the parameters describing current water supply were significant. The insignificance of some policy relevant variables, such as age and location of respondent, is likely due to choice homogeneity in the respondent pool representative of a homogenous population.

6   The demand for improved water services

Table 5 shows the average willingness to pay for an upgrade in the service level from the current status quo level to the ideal level described in the CV scenario for users of different current primary sources. The monthly WTP for exclusively in-house piped connections is 20% lower than the average bill (TT$128 per quarter) measured in the survey. Given that 75% of the respondents paid their water bills within one month, it is most likely is that those with coping infrastructure, such as local storage, to alleviate the inconvenience associated with the poor supply, have a lower demand for service level changes.

The WTP for improved service by users, who use the WASA in-house connection as their primary source of water but also depend upon secondary sources to supplement their primary source, is lower that those who depend on WASA entirely. The WTP of such users is 99TT$/quarter or 40% lower than current average bills. Most likely such respondents assume that any improvement in the WASA supply will not remove the requirement of depending upon secondary sources, and so will not reduce the coping costs associated with their water supply.

Users without an in-house piped connection are willing to pay for the service upgrade associated with the CV scenario. This implies that the CV assessment is sensitive to scope (e.g. Smith and Osborne, 1996) as the scenario offered to such respondents included the added benefit of a service upgrade to an in-house connection. These users are willing to pay TT$175/quarter or a 10% increase over the current average in-house bill. This result implies that the value

users derive from water supply connections resides in the proximity of supply as intermittence can be circumvented through the installation of inexpensive plastic storage tanks at the point of use. Though many standpipe users have local tanks, the distance to the standpipe and the need to share access with other users in the vicinity makes it more difficult to fill and use those tanks, so the utility associated with a service upgrade, in terms of distance to the water source, is larger.

In 1994 (Mycoo, 1996) a survey was carried out in the east-west corridor of Trinidad, between Port of Spain and Arima, to assess the WTP for water service improvements. At that time households were WTP, on average, TT$208 per quarter and 80% of the sample was WTP more than they were currently paying. The current survey found the average WTP to be TT$ 140 per quarter for the nation-wide sample and TT$ 143 per quarter for the East-West corridor. Therefore the WTP for service improvements has eroded over the past decade. The first and most significant reason is the continued poor performance of the water utility (Virjee and Gaskin, 2003). As the utility, through numerous local management changes and an international management contract, has failed to improve service and has been continually chastised in the media for corruption, users are no longer waiting for or believing in the possibility of change. It is also reasonable to assume that increased investment in coping mechanisms has made users somewhat immune to the intermittence of water supply. This argument is supported by the finding in this survey that 68% of the respondents had water tanks whereas only 37% had tanks in 1994 (Mycoo, 1996).

7 Policy Conclusions

This survey shows three main results. First, the current water service levels in Trinidad and Tobago are deficient, second, that, in 2004, there appeared to be no consumer surplus with which to finance service changes through increased tariffs and lastly that WTP is only elastic to consumer income. Services are characterized by intermittent supply, variable pressure and quality. As a result, users have invested in coping mechanisms, the most prevalent being inexpensive plastic tanks. The willingness to pay for improved water sources has been eroded over time mostly due to inefficient management of the utility, and decreasing levels of service in recent years (WASA, 2007). Private sector involvement in the utility in the mid 1990s did not repair the utility and the significant politicization of that effort has effectively closed that route to utility reform. Users who currently use low levels of service, such as standpipes, are willing to pay more for improved services, due to the convenience of proximity rather than availability of water. As installed coping mechanisms are long lasting, it is difficult to see how changes in the reliability of supply will increase the willingness to pay for the improved service as capacity to cope remains at no additional cost to the user and limitations in the CV method prevent analysis of such partial policy changes. The results of the survey depend heavily upon the question posed in the CV scenario. As such, the single 'ideal' situation can miss capturing consumer surplus existent for changes in other ways and there is potential for misspecification of the scenario. Methods which allow for the exploration of such attribute based changes in policy, such as choice modelling (e.g. Louviere et al., 2000), provide promise in this regard.

These survey results imply numerous issues for policy makers in the future. There has not been sufficient tariff increase to sustain sufficient capital investment, service expansion and maintenance at the utility. Using the CV method, this study has shown that, in 2004, the willingness of water customers to finance the gap between the costs and the revenues at the utility is minimal even with large improvements in the quality of service. Whereas in 1994 users were willing to pay almost double their current bills, users presently are almost unwilling to pay current rates.

This makes the task of the regulator and water authority difficult. To increase service levels by installing infrastructure requires increased finance, while to increase rates at present would most likely be politically expensive or would require a significant education and consultation campaign. Ultimately rates must cover costs for the utility to be sustainable. The regulator could institute a service level linked tariff, and, though such a regulatory mechanism may be expensive, the need for such information and management systems is required to allow for long term utility planning.

The vision 2020 program of GORTT has provision of water as one of its goals and it proposes to reach this goal by increasing tariffs to reflect the cost of supply. The Regulated Industries Commission (RIC) has the task of setting the tariffs and has been undertaking economic analyses and, due to the low WTP, an extensive stakeholder education and consultation program to propose management changes and an increase in tariffs that reflects the cost of supply. In the short term the minimum service will be raised to 2 days supply per week (WASA 2008b). In RIC's 2008 proposal (WASA, 2007) water charges will be the sum of variable costs, which are based on volumetric consumption instead of annual rateable value, and fixed costs, which are split 20% to 80% for the domestic and non-domestic classes respectively, and will include several mechanisms to subsidize low income users. The rate structure reflecting the calculated cost of supply to users in two classes is TT$2.64/m3 for domestic users and TT$28.92/m3 for commercial, industrial and agricultural users. The industrial area at Point Lisas, which is supplied by a desalination plant, will be charged TT$6.08/m3 which reflects 75% of the desalination costs. These proposed rates will result in an average increase in domestic user charges of 177%. RIC intends to revise these rates once the universal metering program enables a more accurate calculation of water use and hence unit costs for the previously un-metered domestic class. The proposed rate increases is beyond the WTP determined in this study in 2004 but in the range of the WTP found in 1994 (Mycoo, 1996) when a higher service level existed.

References

Altaf, M., and Hughes, J. (1994) Measuring the demand for improved urban sanitation services: Results from a contingent valuation study in Ouagadougou, Burkina Faso. *Urban Studies*, **31(** 10):1763-1776.

Altaf, M., Jamal, H., Whittington, D. (1992) *Willingness to pay for water in rural Punjab, Pakistan.* Water and Sanitation Report 4. Water and Sanitation Program. World Bank.

Ardila, S., Quiroga, R., Vaughn, W. (1998) A Review of the Use of Contingent Valuation Methods in Project Analysis at the Inter-American Development Bank. No. ENV-126. Inter-American Development Bank. Washington, DC.

Briscoe, J., Furtado de Castro, P., Griffin, C., North, J. and Olsen, O. (1990) Toward equitable and sustainable rural water supplies: A contingent valuation study in Brazil, *The World Bank Economic Review*, Vol. 4, No. 2, pp. 115-134.

Central Statistical Office (CSO). (1989). *Revised Design of the Continuous Sample Survey of Population.* Methodology Report. Government of Trinidad and Tobago.

Central Statistical Office (CSO). (1989). *Revised Design of the Continuous Sample Survey of Population.* Methodology Report. Government of Trinidad and Tobago.

Delcan International Corporation (1992) Feasibility study on Cost/Benefit Analysis of Universal Metering in Trinidad and Tobago, Final Report.

Louviere, J., Hensher, D., Swait, J. (2000) *Stated Choice Methods: Analysis and Application*, Cambridge University Press, Cambridge, UK.

McPhail, A. (1993a) Overlooked market for water connections in Rabat's shantytowns, *Journal of Water Resources Planning and Management*, Vol. 119, No. 3, pp. 388-404.

McPhail, A. (1993b) The 'five percent rule' for improved water service: can households afford more? *World Development*, Vol. 21, No. 6, pp 963-973.

Menard, S. (2002) *Applied Logistic Regression Analysis.* Second Edition. Quantitative Applications in the Social Sciences. Sage Publications.

Mycoo, M. (1996). *Water Provision Improvements: A Case Study of Trinidad.* PhD Thesis, School of Urban Planning, McGill University.

Randall, A., Ives, B. and Eastman, C. (1974) Bidding games for valuation of aesthetic environmental improvements, *Journal of Environmental Economics and Management*, Vol. 1, pp. 132-149.

Regulated Industries Commission (RIC) (2003) *Review of the Current State of the Water and Sewerage Authority (WASA)*, Information Document, RIC, Port of Spain, Trinidad.

Satterthwaite, D. (2003) The Millennium Development Goals and urban poverty reduction: great expectations and nonsense statistics. *Environment and Urbanization,* Vol. 15, No. 2, pp. 181-190.

Smith, V.K., Osborne, L.L. (1996) Do contingent valuation estimates pass a 'scope' test? A meta-analysis, *Journal of Environmental Economics and Management*, Vol. 31, pp. 287-301.

Stiggers, D. (1999) Private participation in water and wastewater services in Trinidad and Tobago, in *Can Privatization Deliver? Infrastructure for Latin America*, eds Basanes, F., Uribe, E., Willig, R., Inter-American Development Bank, Washington, DC.

Virjee, K. (2004) *The Willingness to Pay for Changes in Water, Wastewater and Electricity Services in Trinidad and Tobago*, Working Paper, Water Resources Planning and Management, Department of Civil Engineering and Applied Mechanics, McGill University.

Virjee, K. and Gaskin, S. (2003) Water supply and sanitation provision with private sector participation: A case study of Trinidad*, XI World Water Congress*, International Water Resources Association, Madrid, Spain, 10 pgs., 5-9 October 2003.

Water and Sewerage Authority (WASA) (2002) *State of the Utility*, Status Report.

Water and Sewerage Authority (WASA), (2007), WASA Business Plan for 2007-2011 Revised Draft, July 2007. Webpage :

http://www.ric.org.tt/consultations/WASA/2008/Wasa%20BP%202008%20Complied.pdf

Water and Sewerage Authority (WASA), (2008a) Water and Sewerage Authority Proposed Tariff Structure – Methodology (2006-2007) Draft. Webpage:

http://www.ric.org.tt/consultations/WASA/2008/SupplementaryinfoforWasaBP.pdf

Water and Sewerage Authority (WASA), (2008b) Regulated Industries Commission's public consultation on the Water and Sewerage Authority's application for a rate review, 2008. Webpage: http://www.ric.org.tt/consultations/WASA/2008/RIC%20Presentation%20on%20WASA%20Application%20for%20a%20Rate%20Review.pdf

Whittington, D, Briscoe, J., Mu, X. (1987) *Willingness to Pay for Water in Rural Areas: Methodological Approaches and An Application in Haiti*. WASH Field Report No.213. United States Agency for International Development.

Whittington, D., Briscoe, J., Mu, X. and Baron, W. (1990) Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti. *Economic Development and Cultural Change*, Vol. 38, pp. 293-311.

Whittington, D., Davis, J. and McClelland, E. (1998) Implementing a demand-driven approach to community water supply planning: A case study of Lugazi, Uganda. *Water International*, Vol. 23, pp.134-145.

Whittington, D., Lauria, D., Wright, A., Choe, K., Hughes, J., Swarna, V. (1993) Household demand for improved sanitation services in Kumasi, Ghana: A contingent valuation study. *Water Resources Research*, Vol. 29, No. 6, pp.1539-1560.

World Bank Water Demand Research Team. (1993) The demand for water in rural areas: Determinants and policy implications. *World Bank Research Observer*, Vol. 8, pp. 47-70.

Young, R.. (1996) *Measuring Economic Benefits for Water Investments and Policies*. World Bank Technical Paper No. 338. World Bank, Washington, DC.

9   Acknowledgements

Table 1: Socio-economic profile of survey respondents

Total number of respondents sampled	1419
Non-response rate	13%

Total number of completed questionnaires	1235
Proportion of females	59%
Proportion of females responsible for bill payment	21%
Median age of respondent	44
Median level of schooling attained	Secondary
Mean monthly household income	TT$2900
Own dwelling currently residing in	59%
Squatting in present dwelling	8%
Proportion of respondents with access to electricity service	92%

Table 2: Primary and secondary source of water

Water source	Primary Number of Households	% of total	Secondary Number of Households	% of HH using secondary source
Piped water supply	889	72	5	2
Standpipe	139	11	83	24
Truck borne water	36	3	62	18
Supply from neighbour	82	7	42	12
Rainwater	79	6	121	36
Natural sources	10	1	27	8
Total	**1235**	**100**	**340**	**100**

Table 3: Water supply level of service by income group

Household income per month	Percentage in group with:		
	In-house piped connection	24 hour water supply	Water storage tanks
Less than TT$ 1500	64%	24%	59%
Between TT$ 1500 and TT$ 5500	76%	25%	73%
More than TT$ 5500	89%	45%	84%

Table 4: Logit model parameters and elasticities[b] (in bold italics) describing the choice to accept the improved water supply service

Variable	Model 1[a] Exclusive in-house piped supply		Model 2[a] In-house piped supply + secondary		Model3[a] Non-in-house piped supply	
Intercept	0.331 (2.37)		-0.453 (1.73)		-0.187 (0.453)	
Price of improved supply (*PIS*) (TT\$/ quarter)	-0.009 (13.03)	*-0.008*	-0.009 (8.16)	*-0.007*	-0.008 (11.56)	*-0.007*
Current bill amount (*CB*) (TT\$/ quarter)	0.004 (7.17)	*0.003*				
Income (*Inc*) (1000TT\$/ month)	0.055 (2.27)	*1.0*	0.110 (2.62)	*2.0*	0.141 (3.23)	*2.6*
If household currently treats water (*TrW*) (1 – No; 0- yes)	-0.201 (1.75)	*-0.12*	0.458 (2.41)	*0.33*		
Number of bathrooms in dwelling (*BR*)			0.803 (3.61)	*0.52*		
Whether HH incurs other water charges (*OCh*) (1 – No; 0- yes)			-0.649 (1.86)	*-0.42*		
Fraction of the week that storage lasts (*St*)					-0.249 (1.71)	*-0.04*
Age group of respondent (*Age*)						
Under 20 years					Base case	
20-29 years					0.400 (1.23)	*0.26*
30-39 years					0.892 (3.66)	*0.57*
40-49 years					0.744 (3.57)	*0.48*
50-59 years					0.568 (2.51)	*0.37*
60 years and over					0.707 (2.91)	*0.46*
Geographic location of HH (*Loc*)						
Port of Spain					Base case	
San Fernando					0.945 (1.76)	*0.61*
Arima					0.331 (0.60)	*0.22*
Rest of Trinidad					0.776 (1.99)	*0.50*
Tobago					0.163 (0.44)	*0.11*
Sample Size	722		167		346	
Likelihood ratio statistic (χ^2)	227		94		177	
Pseudo R^2	0.14		0.14		0.13	
Log-likelihood	-911		-367		-733	

[a]- t-values are in parentheses and all parameters are significant at the 10 percent level unless otherwise indicated. The parameter values indicate the size of the effect on the probability that the improved choice is taken.

[b]- Elasticities defined as % change in WTP resulting from a 1% change in parameter X or quasi-elasticities defined as % change in

WTP resulting from a unitary change in parameter X. % change in WTP based on the average quarterly water bill of the sample (TT$155/quarter) and average parameter values.

Table 5: Mean quarterly willingness to pay for improved water services

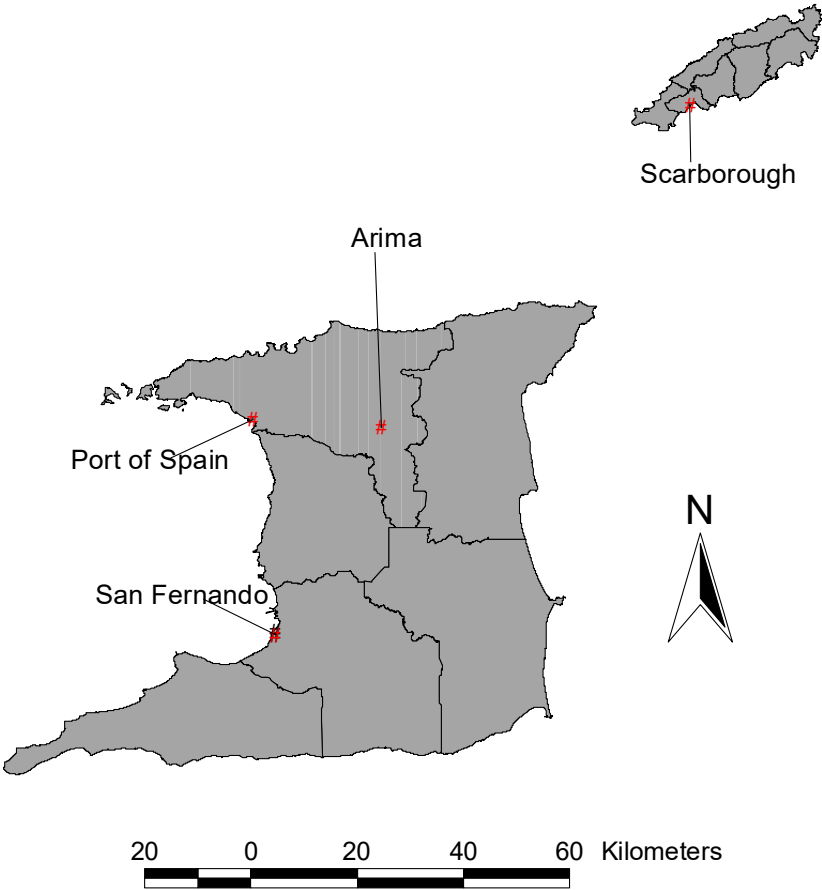| Water source	Mean willingness to pay (TT$/quarter)
WASA in house piped connection only	128
WASA in house connection + secondary source	99
No in-house connection	175

Figure 1: Map of Trinidad and Tobago