WATER CONSERVATION PRACTICES IN THE U.S. VIRGIN ISLANDS BY USERS OF CISTERN, PUBLIC DISTRIBUTION AND COMMERCIAL SYSTEMS

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ABSTRACT

The present study was conducted to determine fresh-water use patterns among domestic users of cistern, public and private commercial systems. The data were gathered via a structured closed-ended questionnaire and analyzed with descriptive statistics. The results show that people tend to conserve water but only through some avenues by which waste is obvious to them. The majority of those interviewed showed a lack of knowledge and use of technologically based water conservation devices. Policies and programs are recommended to increase general awareness and adoption of conservation technology in households.

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INTRODUCTION

Water has always been a scarce commodity in the U.S. Virgin Islands. There are no rivers and streams, and residents must rely on inconsistent and infrequent rainfall to replenish water stored in cisterns or steel barrels, and meager groundwater supplies (Peebles, Pratt and Smith 1979). The traditional methods of collection, storage, and distribution partially fulfill the needs for water, but commercial activities, settlement patterns and the style of life are greatly affected by the lack of an adequate water supply.

The need for additional water has risen sharply in recent years with the growth of the hotel industry and high population growth due to the immigration of people from eastern Caribbean countries, Puerto Rico, Asia and elsewhere in the last few years. The rapidly expanding tourist-based economy and the population explosion require a dependable, economical, consistent and adequate supply of freshwater (Peebles et al. 1979). Given the limited water supply in the territory and the importance of the tourist industry to the local economy, water distribution policy in the future is likely to favor the tourist sector.

Currently, attempts at securing an adequate water supply for Virgin Islands residents have stimulated exploration of a wide range of very expensive alternative freshwater sources for present and projected future demand. Among these are manufactured freshwater (desalinated water), expanded catchments, storage reservoirs, wells, waste water reclamation and commercial production. Already some of these measures have created as many problems as they have solved. For example, the modern desalinization technology used to produce freshwater has been incorporated into a very antiquated infrastructure, resulting in constant breakdown and interruption of services. This condition aggravates an already precarious water supply situation. Because of these problems, Virgin Island residents should be encouraged to participate in efforts to manage the scarce water supply through conservation practices, as a means of coping with current and future shortages.

Efforts in Water Resource Development

The rapidly expanding commercial and residential demand for water is met from three main sources: desalinated water, groundwater and cistern systems. The desalinated water, clearly the most important source, is purchased from the Virgin Islands Water and Power Authority (WAPA) on St. Croix and St. Thomas. Apart from the breakdowns and frequent service interruptions, desalinated water is

extremely costly in terms of energy, capital and operational expenditure.

Groundwater represents a major source of freshwater for St. Croix, but is less important on St. Thomas and St. John. Although it is significantly less expensive than desalinated water, it is sometimes polluted and can have a salty taste that consumers find objectionable (CH2M Hill Southeast Inc., 1983). The high salt content in groundwater is due to prolonged intensive exploitation of this water source, which has lowered the water tables to the point where seawater has seeped into the underground aquifer and replaced freshwater. The loss of these water supplies has aggravated the freshwater problem.

Finally, water harvesting via roof catchment and cistern systems constitutes another source from which residents obtain their freshwater. Roof catchments and cisterns are required by the local government for all new residential constructions, including hotels and condominiums. Although this is an important source of water, it is unreliable during periods of drought and low rainfall. An alternative is for residents to purchase water from private water haulers to refill their cisterns. This approach is very expensive. The cost of water is from forty to sixty dollars for a three-thousand-gallon truck-load of water, depending on whether it is purchased from WAPA, or comes from private wells or rainwater obtained from private storage.

Conservation Efforts

The increasing cost of water has become a burden for residents, who must rely on both the private and public production systems for their water supply. The legislature is involved in an on-going struggle to obtain refunds for the customers of the Virgin Islands Water and Power Authority. At the same time the legislature is trying to obtain reductions in the cost of water to residents. This may be impossible in light of increasing costs of production to WAPA. One method of controlling costs would be for WAPA to produce less and for consumption to be reduced by legally enforced conservation policies, instead of constantly trying to expand production.

To date, water conservation has received little emphasis in public water policy. The first legislative attempt at this approach occurred in 1965, when the legislature passed the Water Conservation Act (Act No. 1344, 12 V.I. Co., Chapter 5), which calls for a prohibition on the ..."wasteful use of water", and established a comprehensive system for regulating the digging of wells and the withdrawal of water (Peebles et al. 1979). However, the law made no provisions for legally enforcing conservation measures. Some consumers now try to conserve water by reusing water for gardening and other purposes. However, this is voluntary, and done by only a few home owners, hotels and condominiums (Peebles et al. 1979). Because conservation is voluntary, it lacks the coercive power that

only official policy can give. Neither the government nor private research has determined how residents use freshwater, although both the government and the University have conducted studies to determine demand.

To increase production of freshwater as usage increases does not adequately solve the water crisis situation in this territory. Empirical research on conservation practices should be undertaken as an integral part of water production plans. With the need for information on how Virgin Islands residents use freshwater, this study was conducted to determine water conservation practice policies needed for the Virgin Islands. To the extent that the need for conservation practices is established through this research effort, policy-makers will be better informed concerning the needs of their constituents, and will gain the potential to approach problem resolution from the perspective of conservation.

LITERATURE REVIEW

The literature on water conservation research was reviewed to determine the factors which affect water conservation behavior among mainland and local residential users. Unfortunately, relatively little literature exists on the topic. This is ironic in view of the fact that water scarcity and conservation issues have received considerable coverage both in the print and visual media. Most of the empirical research that has been conducted has been carried out by municipalities, and the emphasis, for the most part, has been one of determining water use patterns of business and industry.

The states of Arizona and California have been in the forefront of water conservation research, but much of the information resulting from their efforts has been concerned primarily with exploring conservation practice needs for consumers. In very few instances has existing research isolated residential users with a view to determining factors that relate to water use behavior. In their review of the literature on water resource development, Napier, Scot, Foster and Sapella (1983) found that for a 20-year-period (1963-83) only a few more than twenty bibliographies and literature reviews have been published on the social factors that affect water resources. Of these, most are concerned with Government legislation and law, and the cost benefit associated with water resource development. The

search for a general theory of water conservation specifically relating to residential users has also been unproductive. Much of the existing water conservation research has been conducted by development sociologists, and these studies have been concerned, primarily, with water use behavior in the farm sector (Napier et al. (1983).

The need for water conservation research on residential users is therefore undeniable; especially in view of the fact that, unlike other natural resources, there are no substitutes for water. When residential freshwater reserves in springs, catchments and elsewhere are depleted, consumers are inconvenienced and must face prohibitive costs for exploiting alternative sources. For many communities negative consequences of water scarcity are unnecessary; the problem could be avoided by more effective management of existing water supplies. However, more effective water management can only be achieved, if it is based on a sound knowledge of how social-behavioral factors relate to water use practices.

Although sparse, the available research literature has provided some important insights on factors that relate to water conservation behavior. For example, Woodard and Rasmussen (1983), found pricing factors to be very important in encouraging conservation by residential users. People who are appropriately charged for the water they consume, use less, especially if there is an increase in price with increase in use. Most writers are convinced that the low

cost of water is the major contributor to waste of water by residential users. In a water scarcity region such as Arizona, the water management strategy that is employed to encourage conservation includes the imposition of water quotas.

Users who exceed their quotas risk increased costs or the interruption of water services for a designated period of time. Additionally, Woodard et al.(1983) found that households which directly pay their water bills consume considerably less than those that do not. The ability to pay, as expressed in income, is also an important predictor of residential water use patterns (Woodard et al. 1983). Carlile (1983) concluded from his research, that income is frequently expressed in water conservation practices, with higher income people more prone to switch to conservation measures. Such measures include the use of desert vegetation instead of grass lawns, altering plumbing, as well as other changes that cost money. He also found that lower income people resort to other, less costly, conservation measures, such as not letting the water run in the sink and keeping the faucet in repair (Carlile, 1983).

Additionally, the literature reveals that other factors such as age, home ownership, length of residence (seasonal or year round), size of family, educational and occupational achievement, are important in explaining water use patterns (Woodard et al. 1983). Additional factors, such as size of wash load, use of a washing machine, method of washing

dishes, attention to broken or malfunctioning plumbing fixtures, the use of water-saving appliances, such as low-flush toilets, and water-saving devices in the bathroom, kitchen and elsewhere, all affect residential water use patterns (Woodard et al. 1983). Only a few of the variables delineated in the literature will be included for analysis in this study.

The following objectives provide the general thrust of this research project:

Objectives

This study was undertaken to determine the extent to which Virgin Islands residents conserve water. The literature review revealed that several factors tend to influence water use behavior. While this information is useful, it does not provide a comprehensive view of the social factors that explain conservation behavior. The following stated objectives will serve to broaden as well as to focus the scope of this study.

Objective 1. To determine the extent to which Virgin Islands residents conserve water.

Objective 2. To ascertain the extent to which Virgin Islands residents are aware of, and use water conservation measures that are utilized in water scarcity zones on the U.S. mainland.

Objective 3. To determine the methods and devices of conservation most often used by residential users.

Information sought at this point moved beyond the awareness of conservation information technology and mechanized technology into determining whether people actually employ such information and technology when using freshwater.

Objective 4. To examine perceptions of water use patterns and perceptions of availability of freshwater resources. Perception-type variables were carefully selected and integrated into the measuring instrument to assist in determining how residential users view their freshwater resource base (depletable or inexhaustible). If users view this resource as depletable, they would be more inclined to conserve it. On the other hand, if this resource is believed to be inexhaustible, people will tend to be less concerned about conserving it.

Objective 5. To assess the immediate and future socio-economic gains to Virgin Islands residents once the institutions of practice becomes the norm.

RESEARCH METHODOLOGY

Data were collected via an interview schedule administered from January through May, 1988 using a multi-stage area probability sampling lapproach in selecting a representative sample. The sampling design ensured that every head of household in the three major U.S. Virgin Islands, except those living in houseboats, boats or in institutions, had a known chance of being selected as a unit of the study sample. By using this sampling procedure, the views expressed by respondents in the sample closely approximated the views that would have been expressed by the population as a whole, had every head of household been interviewed. The target population for this study consisted of heads of households who are users of cistern systems and/or the Territory's potable water systems (public or commercial).

Data Collection

The data collection process followed a number of steps. The first step involved generating a sampling frame. It was generated from enumeration district (ED's) maps of the Virgin Islands, which were derived from the 1980 Virgin Islands census of population and housing. It was determined from these ED maps that the Virgin Islands consisted of 316 ED's. These ED's were stratified geographically, and a pair of ED's was selected randomly from each stratum based on the probability proportional to their size.

A listing of each residential unit within each selected enumeration district was undertaken as a second step in the

data collection process. A "house listing sheet" was created which provided for the appropriate numbering of each residential dwelling in the enumeration district. Where apartments are indicated, provisions were made to list each unit separately. Residential units were listed as either occupied or vacant. A small number of dwellings was selected randomly from the listing of each ED.

A third step of the data collection process involved the actual interviewing of the respondents. The selection of respondents to be interviewed was based on selection intervals generated from the house listing sheet. Once the household to be interviewed was determined, trained interviewers visited each selected housing unit. Subjects were asked to give the most appropriate response to each question, and enumerators indicated the respondents' answers to each question on the schedule. Only heads of households were permitted to participate in the interview. Enumerators were instructed to return to the homes of selected respondents if the subjects were not available for an interview at the time of the initial visit. Previous research has shown that the interviewing technique employed in this study is a valid and reliable method for collecting sample data from a population of household (Single, Kandell and Faust, 1975; Hardt and Peterson-Hardt, 1977; Mills, 1982).

The present study targeted five hundred (500) respondents for its sample. It obtained 420 completed

questionnaires; a completion rate of 84 percent. This rate compares favorably with similar rates for multistage samples survey conducted in the continental United States.

Sampling Scheme

In a area sample of this kind, it is important to obtain a reliable and representative sample. This was obtained via a reliability estimate that was formulated and advanced by Kish (1965) and tested locally by Mills (1982) in a household survey. Given a target of 400 completed interviews, the total number of dwellings in the sample was determined with an equation involving the rates of occupancy and completion rate of interviews (Warwick and Lininger, 1975):

$$\frac{\text{Completed Interviews}}{400} = \frac{\text{Completed Interviews rate}}{(0.95)} \times \frac{\text{Dwelling use rate}}{(0.84)} \times \frac{\text{Dwelling to be selected}}{X} = 500$$

Therefore, it required a sample size of about 500 dwellings to yield approximately 400 completed interviews, the number required for a reliability estimate of five percentage points for each item to which all household respondents..

The following data show the distribution of the sample size of 500 households among the three islands comprising the Virgin Islands.

Island	Sample Size
St John	25
St. Thomas	225
St. Croix	250
Total	500

In selecting the housing units, the enumeration districts (ED's) or primary sampling units (PSU's) were determined by geographically grouping the ED's, and then dividing them into about 20 strata of approximately the same size of 1672 households in each. The strata are distributed as follows: one on St. John, nine on St. Thomas, and 10 on St. Croix.

Forty PSU's were drawn into the sample, two from each stratum. Each of the forty PSU's was drawn with a probability proportionate to the size of the number of dwelling units in each enumeration district. Thus, the greater the number of housing units in a PSU, the greater its chance of entering the sample.

Having identified 40 PSU's for interview, baseline maps were prepared. The next step was to select the household to be interviewed. The selection process had to guarantee that

each household had an equal probability of being selected for an interviewing. To obtain the selection probability to be applied to each of the 40 PSU's, it was necessary to make use of the following selection equation (Kish, 1965):

$$\frac{2\text{Mos Á}}{2\text{Fb}} \times \frac{b}{\text{Mos Á}} = \frac{1}{F} = F$$

Where Mos Á is the number of housing units in the PSU, and b is the desired number of dwellings from which respondents are selected to be interviewed in each cluster. The expected yield of dwellings in each PSU was or 12 or 13 dwellings for each of the 40 PSU's, thus giving 500 interviews total. This constant yield of 12 or 13 dwellings per PSU occurred specifically because of the selection of PSU's with probabilities proportional to size (PPs), and because the formulas presented above lead to equal F's or equal overall probabilities of selection from strata of about the same size, i.e., about 1672 household units. Once the selection rate was determined for each PSU, it was applied to the list of housing units for each PSU in question. The principles of systematic sampling, including a random start within the interval, was applied to produce the sample addresses scattered throughout the PSU. Data for the study were obtained using a structured close-ended questionnaire.

Socio-Demographic/Residential Characteristics

The sample for this study consisted of 420 respondents. The socio-demographic and residential characteristics are illustrated in **Tables 1 to 12**. The data indicate that about one-half of the sample (54 percent) were ages 26-45, and a little more than one-third (35 percent) were 46 and older.

In terms of the racial composition of the sample, more than half (61 percent) were black, 20 percent were white, 12 percent was black of Hispanic origin, 2 percent were white of Hispanic origin and less than one percent were Asian. Three percent of the respondents did not identify with any of the aforementioned racial groups.

Three quarters of the sample (76 percent) had completed high or junior high school, and only 11 percent had finished college. Less than 2 percent had no schooling.

For occupational groups, data show that almost one-third (29 percent) of the sample claimed to be from the managerial and professional class. Less than a quarter (22 percent) were involved in service occupations, one percent was seasonally employed and less than five percent were unemployed.

In terms of income, slightly more than one half (51 percent) consider their family income to be average, about

21 percent said below average, and 18 percent claimed above average income.*

Information on family composition was also garnered data. As illustrated in the below table, more than one-half (53 percent) had a family size of between three to five people, 32 percent had one to two people, 12 percent with family size of six to eight people and 2 percent with more than six people in the family.

A number of variables were assessed to determine the residential characteristics of the study area. Questions on value of dwelling, living arrangements, type of dwelling, time spent in the Virgin Islands, length of stay at current address and value of place of residence were included on the measuring instrument to achieve this objective.

In terms of residential characteristics, a majority(38 percent) of those interviewed claimed a value of between $50,000 to $102,000 for the place where they live. One half (50 percent) said they were buying or owning and 61 percent of those sampled lived in single family dwellings. A majority of these structures ranged between one to twenty-one years old. Most of the respondents(96 percent) live in the territories on a year round basis with one half(50 percent) having lived in the Virgin Island from between one to ten years.

*U.S. Department of Commerce statistics show that average income for an American family of four, as late as 1985, was $10,980.

Table 1. Age of Respondents (N = 420)

Years	N	Percent
18-25	39	9.3
26-35	94	22.4
36-45	132	31.4
46-55	66	15.7
56-65	48	11.4
66 and Over	32	7.6
Do Not Know	4	1.0
No Response	5	1.2
TOTAL	420	100.0

Table 2. Respondents by Race (N = 420)

Racial Groups	N	Percent*
Hispanic Black	51	12.1
Black	257	61.2
Hispanic White	8	1.9
White	84	20.0
Asian	3	.7
Others	11	2.6
No Response	6	1.4
TOTAL	420	100.0

*Percentage may not add to 100.0 due to rounding error.

Table 3. Education Level of Respondents (N = 420)

Education Level	N	Percent
No Schooling	5	1.2
Elementary	36	8.6
Junior High	189	45.0
Senior High	130	31.0
College	44	10.5
Do Not Know	10	2.4
No Response	6	1.4
TOTAL	420	100.0

Table 4. Occupation of Respondents (N = 420)

Occupation Category	N	Percent
Managerial/Professional	120	28.6
Teacher/Nurse/Secretary	38	9.0
Clerical/ Police	27	6.4
Service Occupation	91	21.7
Laborer/Farmer/Taxi	62	14.8
Housemaker/Retired	56	13.3
Unemployed	19	4.5
Seasonally Employed	3	.7
No Response	4	1.0
TOTAL	420	100.0

Table 5. Family Income of Respondents (N = 420)

Family Income	N	Percent*
Below Average	89	21.2
About Average	212	50.5
Above Average	75	17.9
No Response	44	10.3
TOTAL	420	100.0

*Percentage may not add to 100.0 due to rounding error.

Table 6. Family Size of Respondents (N = 420)

Number of People	N	Percent
1-2	134	31.9
3-5	222	52.9
6-8	52	12.4
9 or More	7	1.7
Do Not Know	2	.5
No Response	3	.7
TOTAL	420	100.0

Table 7. Value of Residences of Respondents (N = 420)

Value	N	Percent
Do Not Know/No Response	125	29.8
Less Than $50,000	46	11.0
$50,000-$76,000	66	15.7
$77,000-$102,000	47	11.2
$103,000-$128,000	16	3.8
$129,000-$154,000	22	5.2
$155,000-$180,000	14	3.3
$181,000-$206,000	25	6.0
$207,000 And Over	52	12.4
No Response	7	1.6
TOTAL	420	100.0

Table 8. Living Arrangements of Respondents (N = 420)

Accommodation Types	N	Percent*
Renting	202	48.1
Buying	30	7.1
Own	182	43.3
No Response	6	1.4
TOTAL	420	100.0

*Percentage may not add to 100.0 due to rounding error.

Table 9. Respondents' Dwelling Types (N = 420)

Dwelling Types	N	Percent
Apartment	120	28.6
Duplex/Triplex	25	6.0
Mobile Home	4	1.0
Single Family	255	60.7
Town House	7	1.7
Condo	2	.5
Public Housing	6	1.4
No Response	1	.2
TOTAL	420	100.0

Table 10. Age of Housing Occupied by Respondents (N = 420)

Age	N	Percent*
Less than 12 months	5	1.2
1-10 years	98	23.3
11-21 years	153	36.4
22-32 years	45	10.7
33+ years	40	9.5
Do Not Know	79	18.8
TOTAL	420	100.0

*Percentage may not all add to 100.0 due to rounding error.

Table 11. Time Spent by Respondents in the V.I. (N = 420)

Season	N	Percent
Year Round	402	95.7
Winter Elsewhere	10	2.4
Summer Elsewhere	2	.5
Do Not Know	4	1.0
No Response	2	.5
TOTAL	420	100.0

Table 12. Length of Time Spent by Respondents at Current Address (N = 420)

	N	Percent
Less Than 12 Months	66	15.7
1-10 Years	209	49.8
11-21 Years	104	24.8
22-32 Years	24	5.7
33+ Years	16	3.8
Do Not Know	1	.2
TOTAL	420	100.0

MEASUREMENT OF VARIABLES

The variables used for this study were derived from five broad categories of conservation factors. These include: attitude toward water availability and conservation, source and cost of water supply, water purchase, water-use patterns and behavior. Personal characteristics of respondents were also assessed. It is believed that these factors directly influence water conservation behavior.

Attitudes Toward Water Availability

Attitudes toward water availability and water conservation were measured using a number of related variables. These include: perception of water availability, perception of water wasting practices, and perception of the importance of conservation practices.

Respondents were asked to rank their attitudes toward these factors by choosing from five possible scale responses created by Likert (1932): "strongly disagree," "disagree," "undecided," "agree," and "strongly agree,"*

Sources of Freshwater

Respondents were asked where they received freshwater for home use. The responses were cistern systems, "potable water (from commercial/Water and Power Authority(WAPA)", "private well", "potable water (trucked)", "cistern and potable water systems".

Information was sought on commercial water purchase by the respondent or the landlord within the past year in order to determine the relative frequency of purchase. The respondents were asked whether they or their landlord purchased water during the past 12 months. The possible responses were "yes" and "no".

* "Don't know" and "no response" are options included for all variables.

The respondents were also asked to note the "average cost for water per year by haulers". The possible responses were "less than $60", "$60 - $120", "$121 - $180", "$181 - $241", and "$242 - $302" . Respondents were asked to indicate how they felt about the cost of this water, and the possible responses were as follows: "very expensive", "moderately expensive", "neither expensive nor cheap", "moderately cheap", "very cheap".

The variable "water purchase from WAPA" was measured by asking respondents if they purchased water from WAPA. The possible responses were "yes" and "no". A "yes" response to the above question required a stated monthly billing amount. Perception of the cost of water secured from WAPA was measured using the following responses: "very expensive", "moderately expensive", neither expensive or cheap , "moderately cheap", and "very cheap".

Water Use Patterns & Conservation Behavior

The respondents were asked to note how they use freshwater. This information was obtained by examining water use patterns and the employment of conservation measures and devices by residential users. Variables to be measured included: use of freshwater, use of washing machine at home, reuse of freshwater (grey water), conservation devices used in bathrooms, frequency of toilet flushing, methods of bathing, methods of showering, leaving the water running while brushing the teeth, car ownership,

frequency of car wash, method of cleaning household laundry, leaking faucets in the home, length of time taken to fix leaking faucets, cultivation of lawn and gardens, household reduction of water use, and utilization of water-saving devices.

Respondents were asked if they used a washing machine at home; (possible responses: yes or no). Respondents were also asked if they "reuse freshwater after it has been used previously (grey water);" (possible responses: yes and no). If the respondent indicated that he/she reused water, he/she was asked to tell how water was reused. Possible responses include: "toilet flush", "car wash", "wash dishes", and "others".

Information was solicited on use of conservation devices in residential bathroom facilities. Respondents were asked to indicate the "type of toilet system they used". Possible responses were: "common white ceramic type with hand lever", "stainless steel with push button", "low flush".

Frequency of "toilet flush" seriously affects water use patterns. Information on the variable was obtained by asking respondents to indicate the number of times during the day that the toilet was flushed.

Information on water use patterns was also determined via the method of bathing. The possible responses were: shower, tub bath, others. Respondents were asked to tell how they used water while showering. The four response

categories were: "apply soap while the shower is running"; "turn off the faucet, apply soap, then shower"; "run water until it gets warm, then soak, apply soap, then wash"; "others."

Respondents were asked if they frequently "leave water running from the faucet while brushing teeth". Response categories were: "yes", or "no".

The respondents were asked if they owned a car. The possible responses were: "yes" and "no". If "yes", respondents were asked how many cars they owned. Data on conservation practices were obtained from respondents by asking them to indicate how often they or members of the household wash the family car(s) with freshwater. The responses were: "don't wash the family car", "once per week", "twice per week", "three or more times per week", "don't have a car".

Information on method of cleaning household laundry as an indication of conservation behavior was measured using four indices: "commercial laundry", "washing machine at home", "wash by hand", and "other". If a respondent cleaned laundry by machine at home, they were asked "how many times per week they did laundry". The responses were: "at least once", "twice", "three or more times".

The size of the wash-load that the respondent must have before deciding to operate the washing machine at home was measured in four response categories: "half-load", "full-load", "less than half-load", and "a few pieces of soiled

laundry". Respondents were also asked whether members of the household washed their soiled laundry separately, with a possible response of "yes" or "no".

Information on conservation practice was further obtained by asking respondents to tell if they had any leaking faucets in the home ("yes" or "no"). If the response to this question was "yes", respondents were asked to tell how long they usually waited before having a leaking faucet fixed. Choice of responses were: "sometimes up to one week", "several weeks", and "months". Respondents were also asked to recall whether they ever heard a hissing sound in the commode in the house. The possible responses were "very seldom", "seldom", "sometimes", "frequently", "very frequently", "never", and "don't have a commode in my house".

The cultivation of a lawn, vegetable garden, or flower garden has always been recognized as a water-intensive activity. Respondents were questioned to determine if they engaged in any of these activities. If "yes", they were asked to tell how frequently they watered their garden. The possible responses were: "once a day", "every other day", "two days per week", "never water".

Information on respondent's effort to conserve water was obtained by asking if they ever considered reducing the amount of freshwater their household uses. The possible responses were "yes" or "no".

Respondents were asked to provide information on use of specific water-saving devices as a means of determining water conservation practices among residents. Respondents were asked if they used low-flow faucets throughout the house; low flow shower heads, shower cut-off valves, shower head inserts, or shower aerators in the bathroom; toilet dams in the commodes; washed dishes by hand; or washed dishes by dishwasher. The responses were "yes" or "no".

RESULTS

The data presented in this chapter were derived from a research survey of conservation practices among residential users of public distribution, commercial and cistern water systems in the Virgin Islands. The following results derived from the study, reflect the research objectives listed earlier.

The data on water conservation have been analyzed and presented in the following section.

Perception of Abundance of Fresh Water in the Natural Environment

Data presented in **Table 13** provide information regarding the way people view water as a natural resource. When asked about their perception of abundance of water in the natural environment, 76 percent of the sample disagreed that water is in abundance. Only 18 percent indicated that there is an abundance of freshwater supply in the natural environment.

Table 13. Perception of Abundance of Water in the Natural Environment (N = 420)

Response	Frequency	Percent
Strongly Disagree	100	23.8
Disagree	219	52.1
Agree	69	16.4
Strongly Agree	6	1.4
Don't Know	16	3.8
Undecided	8	1.9
No Response	2	.5
TOTAL	420	100.0

*Percentages may not add to 100.0 due to rounding error.

Perception Regarding Availability of Freshwater

Data in **Table 14** are focussed on the perception of Virgin Islands residents regarding the availability of water resources in the territory. The data show that a majority (70%) of those sampled disagree that there is an ample supply of freshwater available to consumers. Only 23 percent believe that water isn't a scarce commodity in the Virgin Islands.

Table 14. Perception of Availability of (Ample) Water Resources to Consumers (N = 420)

Response	Frequency	Percent
Strongly Disagree	86	20.5
Disagree	207	49.3
Agree	83	19.8
Strongly Agree	2	.5
Don't Know	23	5.5
Undecided	17	4.0
No Response	2	.5
TOTAL	420	100.0

Perception of Need to Preserve Freshwater

Perception of the need to preserve freshwater resources is believed to have considerable influence on water conservation behavior. The data in **Table 15** are focused on perception of need to preserve freshwater. As noted in the table, 87 percent of those surveyed think that there is a need to preserve freshwater, while 8 percent do not agree that such a need exists.

Table 15. Perception of Need to Preserve Fresh Water Resources (N = 420)

Response	Frequency	Percent
Strongly Disagree	18	4.3
Disagree	16	3.8
Agree	192	45.7
Strongly Agree	175	41.7
Don't Know	9	2.1
Undecided	8	1.9
No Response	2	.5
TOTAL	420	100.0

Data on perception of water wasting behavior in the home are presented in **Table 16.** When asked how they perceive water use behavior in the community as a whole, 43 percent of those interviewed disagree that people waste water and 42 percent agree that people waste water in the home. At the same time 14 percent of those surveyed were either undecided or don't know whether or not people waste or conserve water.

Table 16. Perception of Wasteful Use of Water in the Home (N= 420)

Response	Frequency	Percent
Strongly Disagree	36	8.6
Disagree	144	34.3
Agree	150	35.7
Strongly agree	27	6.4
Undecided	23	5.5
Don't Know	37	8.8
No Response	3	.7
TOTAL	420	100.0

Perception of Water Use Pattern Among Businesses

The data presented in Table 17 provide information on how people perceive water use patterns among businesses. In this reference, 27 percent disagree that businesses waste water. While 32 percent agree that they do, almost a third indicated that they have no knowledge of water use patterns among businesses.

Table 17. Perception of Businesses Water Wasting Patterns (N = 420)

Response	Frequency	Percent*
Strongly Disagree	13	3.1
Disagree	101	24.0
Agree	116	27.6
Strongly Agree	20	4.8
Don't Know	124	29.5
Undecided	37	8.8
No Response	9	2.1
TOTAL	420	100.0

*Percentage may not add to 100.0 due to rounding error.

Residential Source of Freshwater

Table 18 presents data on residential sources of freshwater on all three islands. The data show that a majority (63%) of those surveyed obtain their freshwater supply from cistern systems, 16 percent from the Virgin Islands Water and Power Authority, 14 percent from a combination of cistern and commercial haulers, 3 percent from private wells and 2 percent from commercial haulers.

Table 18. Residential Source of Water Supply (N = 420)

Response	Frequency	Percent
Cistern	265	63.1
WAPA	65	15.5
Private Well	12	2.9
Trucked	7	1.7
Cistern & Trucked	59	14.0
Do Not Know	7	1.7
No Response	5	1.1
TOTAL	420	100.0

Sources of Freshwater Supply by Island

The data were segmented to show differences in sources of freshwater supply by islands. As illustrated by **Table 19**, 70 percent of St. John residents rely on cistern systems, 64 percent in St. Croix, and 63 percent in St. Thomas. WAPA is the second single largest source of freshwater for residents, and this source accounts for 16 percent in St. Croix and 17 percent in St. Thomas. WAPA does not provide freshwater to St. John residents. A combination of cistern and trucked systems is the third largest source, with 22 percent of the sample from St. John, 15 percent from St. Thomas, and 12 percent from St. Croix, claiming this source.

Table 19. Source of Water by Island (N = 420)

	Island					
Source of Water	St. Croix		St. Thomas		St.John	
	NO.	%	NO.	%	NO.	%
Cistern	124	63.6	125	63.1	16	69.6
WAPA	31	15.9	34	17.2	0	0
Private Well	10	5.1	1	.5	1	4.3
Trucked	2	1.0	4	2.0	1	4.3
Cistern & Trucked	24	12.3	30	15.2	5	21.7
Do Not Know	3	1.5	4	2.0	0	0
No Response	2	1.0	0	0	0	0
Total	196	100	198	100	23	100

Purchases from Water Haulers

The data in **Table 20** show the percentage of the sample who purchase water from commercial haulers. A majority (65 percent) claimed that they did not purchase water from commercial haulers, and 24 percent said they did.

TABLE 20. Consumer Water Purchase From Water Haulers in Previous 12 Months (N = 420)

Response	Frequency	Percent*
Yes	101	24.0
No	274	65.2
Don't Know	27	6.4
No Response	18	4.3
TOTAL	420	100.0

*Percentage may not add to 100.0 due to rounding error.

Household or Landlord's Water Purchases From Commercial Haulers

Table 21 presents data on frequency of household or landlord's average yearly water purchases from commercial haulers. The data show that 14 percent of those interviewed purchased water between one to three times per year, and just 6.7 percent four times or more per year.

Table 21. Frequency of Household or Landlord Water Purchases from Haulers (N = 420)

Response	Frequency	Percent
Once	25	6.0
Twice	21	5.0
Three Times	14	3.3
Four Or More	28	6.7
Do Not Know	19	4.5
No Response	313	74.6*
TOTAL	420	100.0

*The high "no response" rate results from an option which allows respondents to skip this question if they had given a response of "no" to the previous question.

Cost of Hauled Water

The data in **Table 22** show average yearly cost for hauled water to participants in the survey. Of those interviewed, 7 percent spent up to $60 - $120 per year for water from commercial haulers, 5 percent spent between $121 - $302 and another 5 percent spent $303 or more yearly for the same service.

Table 22. Average Cost per Year for Hauled Water (N = 420)

Response	Frequency	Percent
Less Than $60	7	1.7
$60-$120	23	5.5
$121-$180	11	2.6
$181-$241	5	1.2
$242-$302	6	1.4
$303 or more	21	5.0
Do Not Know	27	6.4
No Response	320	76.2*
TOTAL	420	100.0

*The high "no response" rate results from an options which allows respondents to skip this question if they had given a response of "no" to the previous question.

Water Purchase From Wapa

Table 23 presents data on water purchase from WAPA. Of the 420 people interviewed, 26 percent claim that they received water from WAPA and 58 percent claimed not to have received any water from this source. Probably they obtain all their water from cisterns.

Table 23. Purchase of Water From WAPA (N = 420)

Response	Frequency	Percent
Yes	107	25.5
No	242	57.6
Do Not Know	41	9.8
No Response	30	7.1
TOTAL	420	100.0

Perception of Cost for Water From WAPA

The data presented in **Table 24** provide information on the perception of cost for water provided by WAPA. Of the total people surveyed, 20 percent thought that water provided by this source was expensive, 7 percent felt that it was neither cheap nor expensive, and 3 percent claimed that it was cheap. More than one third of those surveyed had no knowledge of the relative cost of water from WAPA, probably because they obtain all their water from cisterns or haulers.

Table 24. Perception of Cost Of Water From WAPA (N = 420)

Response	Frequency	Percent
Very Expensive	55	13.1
Moderately Expensive	30	7.1
Not Cheap or Expensive	28	6.7
Moderately Cheap	11	2.6
Very Cheap	2	.5
Do Not Know	156	37.1
No Data	138	32.9
TOTAL	420	100.0

Respondents Knowledge of Conservation Practice

The data in **Table 25** provide information on respondents' knowledge of water conservation behavior within households. Of the total surveyed, a little more than one half of them indicated that they did not conserve freshwater. At the same time, a little less than one-half claim that they did.

Table 25. Conservation of Freshwater (N = 420)

Response	Frequency	Percent
Yes	194	46.2
No	223	53.1
Do Not Know	2	.5
No Response	1	.2
TOTAL	420	100.0

Household Use of Conservation Measures

The use of water conservation devices such as low-flow faucets has been shown to be a good measure of conservation behavior. Respondents were asked to indicate whether or not they use a low-flow faucet as a water conservation measure in their home. Of the total surveyed, 73 percent claimed not to have used any such device, while 21 percent indicated that they did. (See **Table 26**).

Table 26. Residential Use of Low Flow Faucet Systems (N = 420)

Response	Frequency	Percent
Yes	90	21.4
No	306	72.9
Do Not Know	20	4.8
No Response	4	1.0
TOTAL	420	100.0

Household Use of Bathroom Conservation Devices

Table 27 illustrates level of household use of bathroom shower conservation devices.* More than half (61 percent) said that they did not use such devices, while a little more than one-third (35 percent) said that they did.

Table 27. Use of Bathroom Shower Conservation Devices (N = 420)

Response	Frequency	Percentage
Yes	146	34.8
No	257	61.2
Do Not Know	12	2.9
No Data	5	1.2
Total	420	100.1

*These include: lowflow shower heads, shower cut-off valves, shower head inserts and shower aerators.

Household Use of Toilet Dams

Toilet dams are useful methods of conservation and save water when correctly installed.* Indices were incorporated into the study to determine whether or not residents use this method of conservation. **Table 28** shows the frequency and percentage of the sample which use or do not use toilet dams. The data show that the majority of those sampled (71.4 %) do not use this conservation measure.

Table 28. Use of Toilet Dams (N = 420)

Response	Frequency	Percent
Yes	60	14.3
No	300	71.4
No Toilet	5	1.2
Don't Know	38	9.0
No Response	17	4.1
TOTAL	420	100.0

*Toilet dams are sometimes made from plastic jugs that are cut off at the top and weighted down with a rock or any heavy object to the bottom of the tank of the commode. This practice displaces water while at the same time providing adequate pressure for flushing.

Households with Leaking Faucets

Leaking faucets in the home constitute an important means of freshwater wastage. Data were collected to determine if there were any leaks in household plumbing systems. Data presented in **Table 29** indicate that a majority of those surveyed claimed not to have any leaking faucets in their homes. Only 11 percent said that they did.

Table 29. Households with Leaking Faucets (N = 420)

Responses	Frequency	Percentage
Yes	46	11.0
No	366	87.1
Do Not Know	5	1.2
No Response	3	.7
Total	420	100.0

Time Taken to Fix Leaking Faucets

Data presented in **Table 30** show the average time taken to fix leaking faucets among the households surveyed. The data suggested that most people keep their faucets in good repair. Most (16 percent) of those who answered this question take up to one week to repair their leaking faucets.

Table 30. Time Taken to Fix Leaking Faucet (N = 420)

Response	Frequency	Percentage
Up To One Week	67	16.0
Several Weeks	21	5.0
Months	18	4.3
Do Not Know	38	9.0
No Response	276	65.7*
Total	420	100.0

*The high "no response" rate results from an option which allows respondents to skip this question if they had given a response of "no" to the previous question.

Household Reuse of Freshwater

The data regarding household reuse of freshwater are presented in **Table 31.** Of the 420 people interviewed, a majority (60 percent) claim not to reuse freshwater. Only 39 percent indicated that they find additional use for water after it has already been used.

Table 31. Reuse of Freshwater (N = 420)

Response	Frequency	Percent
Yes	164	39.0
No	253	60.2
Do Not Know	3	.7
TOTAL	420	100.0

*Percentage may not sum to 100.0 due to rounding error.

Uses for Greywater

Data focused on grey water are presented in Table 32. Thirty eight percent (38%) of those interviewed, indicated that they reuse grey water to perform additional water use functions. Of this group, 16 percent of them use grey water to provide toilet flushing functions, 2 percent reuse water to wash car and the same amount use grey water to wash dishes. Nineteen percent (19%) said they use grey water for other functions.

Table 32. Uses for Grey-Water(Except from Bath) (N = 420)

Uses	Frequency	Percent
Toilet Flush	66	15.7
Wash Car	7	1.7
Wash Dishes	8	1.9
Other	80	19.0
Do Not Know	2	.5
No Response	257	61.2
TOTAL	420	100.0

*Grey water is water previously used by a household to wash clothes or bathe after which is used for : flushing toilet, washing cars or gardening.

Household Reuse of Grey Water (Bath)

Table 33 provides data on household reuse of grey water as a conservation measure. A majority of those interviewed (79 percent) claimed not to have reused bath water. Only 21 percent found useful functions for grey water.

Table 33. Reuse Grey Water (Bath) (N = 420)

Response	Frequency	Percentage
Yes	86	20.5
No	331	78.8
No Response	3	.7
TOTAL	420	100.0

Types of Use Made of Grey Water

Table 34 presents data on types of use made of bath grey water. Of the people who reuse bath grey water, 12 percent use it for toilet flushing while another 8 percent find other uses for this type of grey water.

Table 34. Types of Use Made of Bath Greywater (N = 420)

Types of Use	Frequency	Percent
Toilet Flush	52	12.4
Other	32	7.6
Do Not Know	1	.2
No Response	335	79.8*
TOTAL	420	100.0

*The high "no response" rate (80 percent) results from an option which allows respondents to skip this question if they had given a response of "no" to the previous questions.

Residential Toilet Systems in the Use of Households

The data on types of residential toilet systems in use in the Virgin Islands, **Table 35**, indicate that a majority (94 percent) of homes use the common traditional white ceramic type. Three percent use the low flush type, while only 2 percent use the push button type.

Table 35. Residential Toilet Systems (N = 420)

Types	Frequency	Percent
Common Traditional	396	94.3
Push Button	10	2.4
Low Flush	12	2.9
No Response	2	.5
TOTAL	420	100.0

Frequency of Daily Toilet Flushes

Research data regarding frequency of toilet flushes by residents per day (**Table 36**) show that 52 percent of those interviewed indicate that they flush between 3 - 6 times per day. Another 10 percent flush at a rate of 1 - 2 times per day. Twelve percent of the respondents said that they did not know how many times per day they flush the toilet.

Table 36. Frequency of Toilet Flushes per Day By Households (N = 420)

Number of Times Per Day	Frequency	Percent*
1	4	1.0
2	36	8.6
3	43	10.2
4	75	17.9
5	44	10.5
6	55	13.1
7	11	2.6
8	19	4.5
10	31	7.4
11	4	1.0
12	6	1.4
13	2	.5
14	1	.2
15	6	1.4
18	1	.2
20	12	2.9
30	2	.5
32	1	.2
50	1	.2
60	1	.2
99	5	1.2
No Response	9	2.1
Do Not Know	51	12.1
TOTAL	420	100.0

*Percentage may not add to 100.0 due to rounding error.

Choice of Bathing Activity

Respondents were asked to indicate their choice of bathing activity as a method of determining whether people tend to use conservation means when bathing. **Table 37** presents data on choice of household bathing activity. The data show that a majority (89 percent) take showers, 7 percent are tub bathers and 3 percent resort to other means of bathing.

Table 37. Choice of Bathing Activity by Households (N = 420)

Activity	Frequency	Percent
Shower	374	89.0
Tub Bath	31	7.4
Other	11	2.6
Do Not Know	2	.5
No Response	2	.5
TOTAL	420	100.0

Showers Procedures in Households

Data regarding shower procedure by household are presented in **Table 38.** As illustrated, 53 percent of those surveyed follow the practice of soaping while the water is turned-off, 22 percent soap while the water runs and 20 percent run the water until it is warm before taking a shower. Forty two percent of those interviewed on shower procedure engage in some form of water wasting activity.

Table 38. Shower Procedure by Household (N = 420)

Procedure	Frequency	Percent
Soap while water runs	92	21.9
Soap while water is off	223	53.1
Run water until warm	83	19.8
Do Not Know	4	1.0
Other	8	1.9
No Response	10	2.4
TOTAL	420	100.0

Running Water While Brushing Teeth

Running the water while at the same time brushing teeth is erroneously believed to be one of the more frequent violations of household water conservation practices. **Table 39** illustrates the frequency and percentage of those who claim to leave the water running, or not running, while brushing their teeth. As indicated, only 19 percent said they ran the water and 80 percent said they do not run the water while brushing their teeth.

Table 39. Water Running While Brushing Teeth (N = 420)

Response	Frequency	Percent
Yes	78	18.6
No	336	80.0
Do Not Know	3	.7
No Response	3	.7
TOTAL	420	100.0

Washing Face While Running Water

Another potentially wasteful practice is washing the face while the water is running from the faucet. However, **Table 40** shows that the majority (62 percent) of those surveyed claim not to employ this practice while washing the face. A significant amount (38 percent) however, said that they do.

Table 40. Washing Face While Water Running (N = 420)

Response	Frequency	Percent
Yes	154	36.7
No	260	61.9
Do Not Know	1	.2
No Response	5	1.2
TOTAL	420	100.0

Residential Use of Washing Machine

Data on residential use of washing machines are presented in **Table 41.** Of the total people interviewed, 62 percent used a washing machine to clean dirty laundry, 38 percent claim that they do not use a washing machine.

Table 41. Residential Use of Washing Machine (N = 420)

Response	Frequency	Percent
Yes	261	62.1
No	158	37.6
No Response	1	.2
TOTAL	420	100.0

*Percentage may not add to 100.0 due to rounding error.

Method of Cleaning Laundry

Data was obtained on method most often used in washing personal household laundry. As indicated in **Table 42**, 57 percent of those interviewed use a privately owned washing machine, 34 percent use commercial laundry facilities, 6 percent do laundry by hand and 3 percent employed other means of cleaning dirty laundry.

Table 42. Method of Cleaning Laundry (N = 420)

Method	Frequency	Percent
Commercial	141	33.6
Private Washing Machine	241	57.4
Manual (by Hand)	23	5.5
Other	11	2.6
Do Not Know	2	.5
No Response	2	.5
TOTAL	420	100.0

Household Laundry Cleaning Activity

Frequency of cleaning laundry was also, measured. As noted in **Table 43**, of those who responded to the question, 33 percent clean their laundry at least once per week, 15 percent twice per week, and 9 percent clean their laundry three or more times per week.

Table 43. Frequency of Cleaning Laundry (Times per Week) (N = 420)

Times Per Week	Frequency	Percent
At Least Once	138	32.9
Twice	61	14.5
Three of More Times	37	8.8
Do Not Know	1	.2
No Response	183	43.6
TOTAL	420	100.0

*The high "no response" rate of 44 percent is due to an option which allows respondents to skip this question if it was not applicable. This suggests that respondents utilize commercial methods of cleaning. As a continuation of the previous table a response to this question would not be necessary.

Required Wash Load to Operate Washing Machine

The data from the variable: washing load required to operate the washing machine, for those who use privately owned machines, are illustrated in **Table** 44. As noted, nearly half (45 percent) of those surveyed indicated that they operate the washing machine only when there is a full load of dirty laundry. Another 10 percent need only a half load to operate the machine, and less than one percent wash only a few items of dirty clothing at a time.

Table 44. Wash Load Required to Operate Washing Machine (N = 420)

Size of Wash Load	Frequency	Percent
Half-load	43	10.2
Full-load	190	45.2
Few Items of Clothes	2	.5
Do Not Know	2	.5
No Response	183	43.6
TOTAL	420	100.0

Laundrying Wash Separately

Washing clothes separately in a household with many occupants is a potentially wasteful practice. **Table 45** presents data on the household laundrying activities that do or do not wash clothes separately. As noted, 61 percent of those interviewed claimed not to have washed clothes separately while 34 percent admitted having done so.

Table 45. Family Members Laundering Wash Separately (N = 420)

Response	Frequency	Percentage
Yes	141	33.6
No	254	60.5
Do Not Know	9	2.1
No Response	16	3.8
TOTAL	420	100.0

Ownership of Dishwasher

When asked about their ownership of dishwashers, 94 percent claimed not to own any while 6 percent indicated that they do (See **Table 46**).

Table 46. Ownership of Dishwashers (N = 420)

Response	Frequency	Percent
Yes	24	5.7
No	394	93.8
No Response	2	.5
TOTAL	420	100.0

Manual Dishwashing

Table 47 illustrates the frequency and percentage of the people surveyed who do or do not wash dishes by hand. As shown, an overwhelming majority (95%) of those surveyed indicated that they wash dishes by hand, while 4 percent claim not to do so.

Table 47. Manual Dish-Washing Activity (N = 420)

Response	Frequency	Percent*
Yes	400	95.2
No	16	3.8
Do Not Know	1	.2
No Response	3	.7
TOTAL	420	100.0

*Percentage may not add to 100.0 due to rounding error.

Frequency of Washing Car

The frequency with which people use freshwater to wash their auto is a good measure of their water conservation behavior. The data in **Table 48** show that a little more than one-third (32 percent) wash their auto at least once per week, 23 percent don't wash their car, and 9 percent wash their auto between 3 times per week to twice per month.

Table 48. Frequency of Washing Car (N = 420)

Response	Frequency	Percentage
Don't Wash Car	96	22.9
Once/Week	134	31.9
Twice/Week	22	5.2
3 +/Week	8	1.9
1-2/Month	29	6.9
Do Not Know	27	6.4
No Response	104	24.8*
Total	420	100.0

*The moderately high "no response" rate of 24 percent results from an option which allows respondents to skip this question if they do not own a car.

Lawn and Garden Cultivation

Data on lawn and garden cultivation were collected to determine frequency of irrigation by households. As illustrated in **Table 49**, a majority (60 percent) of those interviewed indicated that they do not cultivate a lawn or a garden. A significant number (39 percent) said that they did.

Table 49. Lawn and Garden Cultivation (N = 420)

Response	Frequency	Percentage
Yes	162	38.6
No	253	60.2
No Response	5	1.2
Total	420	100.0

Frequency of Lawn and Garden Cultivation

As illustrated in **Table 50**, of those who irrigate their lawn and garden, 18 percent do so between once per day and two days per week. Three percent said every two or more weeks, six percent said once per week, and nine percent indicated that they never irrigate.

Table 50. Frequency of Irrigation of Lawn/Garden (N = 420)

Response	Frequency	Percentage*
Once/Day	30	7.1
Once Every Other Day	23	5.5
Two Days/Week	23	5.5
Once/Week	24	5.7
Every Two or More Week	14	3.3
Never	39	9.3
Do Not Know	6	1.4
No Response	261	62.1
Total	420	100.0

*Percentage may not add to 100.0 due to rounding error.

DISCUSSION

Overview

This study was developed to: (1) determine the extent to which Virgin Islands residents conserve water, (2) ascertain the extent to which people are aware of,and use water conservation measures that are utilized in water scarcity zones on the mainland, (3) determine the methods and devices of conservation most often used by residential users of freshwater, (4) examine perceptions of water use patterns and perceptions of availability of freshwater resources, and (5) assess the immediate and future socio-economic gains to Virgin Islands residents resulting from conservation of freshwater.

With respect to the first objective of the study, the data show that most Virgin Islands residents do not conserve fresh water. This is especially apparent from the response having to do with uses made of grey water. Grey water (used water) from washing dishes, clothes or bathing may be employed in a number of other uses such as watering plants, toilet flushing etc. Consistently, the results of the study show that a substantial majority of those interviewed claimed not to use grey water for any purpose (including watering lawn and garden and toilet flushing) after initial use. This suggest that households in the Virgin Islands do not maximize the use of its water supply.

Conservation of freshwater can be greatly influenced by the adoption of water conservation measures or devices. Thus, one of the pivotal objectives (objective 2) of this study was to ascertain the extent to which people in the Virgin Islands are aware of certain water conservation measures. The data show that people do employ some types of water-saving measures in their use of freshwater. Take for example their method of cleaning dirty laundry. This is potentially one of the most intensive water-wasting activity among domestic water use areas. Such factors as frequency of cleaning laundry (whether household laundry is washed in bulked or in parts by individual household members), and load size (full, half, less than half load), all impact on use patterns. However, the results for this study show that households were quite judicious with respect to use of freshwater to clean laundry. Most of those interviewed used the washing machine (domestic and commercial) to clean laundry at least once per week; they do not tend to wash clothes in parts; and required a full load before operating the washing machine.

Use patterns involving the toilet, also, heavily impact freshwater resources. For example, frequency of flush among households helps to determine conservation of water in this area. The results show that 52 percent of the people interviewed flush on an average of between three to six times per day. These are acceptable levels and suggest that

there is not a significant problem of people wasting water through flushing.

Running water while soaping, brushing teeth or washing the face are some of the ways people waste large quantities of fresh water. The results of this study show that for the most part people are careful how they use this resource when taking care of personal hygiene. However, there is much to be desired in two of the three methods mentioned above. For example, 42 percent of the study sample run the water either while soaping-up before taking a shower or allow the running water to get warm before use (see **Table 38**); and 37 percent leave the water running to wash face (see **Table 40**). These findings are significant and doubtlessly reflect the reality of common water use behavior among residential users.

Using freshwater to wash automobiles is another important area of wasting domestic reserves. The data on use patterns show that people wash their car relatively often. They, however, conserve water by keeping household faucets in repair and doing dishes by hand.

Determining the methods and devices in use by residential users of freshwater in the Virgin Islands is the third objective of this study. The relevant data revealed that people, for the most part, do not employ methods and devices that conserve freshwater. For example, most residential units (94.3%) are fitted with the traditional water intensive flush toilets. These units use between 5-7 gallons per flush. Additionally, most of those surveyed

(71.4%) do not attempt any mitigation of waste patterns by the use of toilet dam in the tank of the commode. Thus, the data which show that people flush infrequently cannot be accepted as truly reflecting conservation of freshwater.

The data also show that most of the people sampled (73%) do not use low flow faucet systems (toilets and bathroom). Generally people have neglected the use of these conservation devices although they are readily available to the consumer. The traditional water intensive faucets are the types most often use in the homes, which unknowingly to many people, contribute to waste of both financial and water resources.

The perception of water use and perception of freshwater availability among residential users were examined to qualitatively determine if people understand the precarious nature of water supply in the territory. The results show that generally people in the Virgin Islands understand the nature of freshwater supply. This conclusion is supported by the response to the questions having to do with "perceived availability" and perceived abundance" where a majority strongly disagreed with statements in the measuring instrument which suggest that freshwater is in abundance in the natural environment and readily available for consumption. The data show that there is an even split between those who believe and those who do not believe that people in the Virgin Islands waste freshwater in the home, and a similar split between those who disagree that

businesses waste freshwater. However, a strong majority supports the idea of preserving the existing freshwater supply in the natural environment.

IMPLICATIONS AND ALTERNATIVES FOR WATER CONSERVATION POLICY AND PROGRAM DEVELOPMENT

The results of the study provide an initial data base on the state of water conservation practices in the Virgin Islands. The results show that people conserve water, but only in some areas of waste that are obvious to them, and through the use of conservation methods that they are knowledgeable about. Unfortunately conservation practices that are most obvious to people and that they use most often are the ones that are least intensive with respect to water use.

Therefore, one of the most serious problems confronting people relative to the conservation of water in the Virgin Islands is that they do not appear to be aware of advanced technology or technological substitutes that foster conservation of water. For example, the crude method of displacing water in the tank of a commode (using a gallon plastic container weighted down with a heavy object) to provide less water per flush, which has been used for years in drought-stricken parts of the U.S. and elsewhere, is still unheard of in the Virgin Islands. Thus people here continue to waste water without being consciously aware of it. The waste will eventually cause the over-taxing of our natural reserves. Already there is strong indication that the Virgin Islands are experiencing a water crisis due to contamination and over-draught of wells. The current water crisis has contributed to frequent water rationing,

especially on St. Thomas and St.Croix. This has implications not only for the natural environment but our financial resources as well in terms of the increasing cost of production (desalination) and importation in order to meet increasing demands. In view of this, there is a need for widely disseminated information on how people can conserve water through the employment of certain behavior modes and technologically based knowledge and devices.

Recommendations

Consistent with the above, the following policy and program recommendations are suggested:

Recommendation I

That the local government, through the department of Planning and Natural Resources (DPNR),and the Virgin Islands Water and Power Authority (WAPA) undertake the task of educating the public regarding the potential water crisis situation in the Virgin Islands. The visual audio and print media should be utilized in the information dissemination process (see appendix for information on conservation that should be incorporated).

Recommendation II

That the DPNR and WAPA in collaboration with the University of the Virgin Islands and the Department of Education, target school-age youngsters through specially developed video programs on water conservation in the Virgin Islands. Television

stations should be canvassed and encouraged to provide free time to air these programs. Video programs should be made available to all schools, in the territory free of charge.

Recommendation III

That the DPNR and WAPA be legally empowered to institute quotas or allotments to residential and commercial users of freshwater. This recommendation is suggested in light of research which shows that adoption of new behavior is seldom voluntary and isolated from perceived costs or benefits associated with such adoption (Rogers, 1983). In this regard, action should be taken by the responsible agencies to provide a water use quota to residents based on size of households, at an affordable cost per gallon. The rate structure should allow for a graduating charge per increment of water used beyond quota.

Recommendation IV

The Department of Public Works should be empowered to make mandatory, via building codes, the installation of conservation devices such as low-flush toilet systems, low-flow shower heads, shower cut-off valves, showerhead inserts and shower aerators for shower systems, and cut-off valves for kitchen faucets for all new home construction. The DPW should provide a mechanism for encouraging retrofitting of older homes

with conservation devices. One important mechanism for ensuring compliance is to provide a subsidy for installing these systems.

Recommendation V

A new water cost system should be instituted to encourage conservation among water intensive businesses and industries such as car wash and laundries. Additionally, it should be made mandatory for these to recycle and reuse grey water.

Recommendation for Future Research

The present study is a first attempt by an individual or agency in the Virgin Islands to document water use behavior by users of cistern, public and private commercial systems. The pioneering nature of this research therefore predisposes it to some disadvantages such as not having access to previous studies which could have been used as a guide for variable selection and analysis. Consequently, the task of organizing this study became laborious as is characteristic of most "first time studies". Now that this study has been completed, baseline data collected, and the relevant parameters drawn, a future study should be undertaken to determine the correlates of water conservation behavior using the Diffusion and Social Statification theoretical models as the basis for hypotheses testing. For example, the social stratification model hypotheses that people with greater access to economic privileges, financial resources

and/or better educational levels are more adaptive to certain types of behavior. Similarly, the Diffusion model posits that exposure to new information and knowledge along with assess to socioeconomic opportunities and financial resources help facilitate early adoption of new technology (Rogers, 1983). In this context, people who are among the privilege class should be better able to afford and acquire conservation technology, which in turn predispose them to conserve freshwater.

Limitations

One of the major limitations of this study is that it does not provide a broader, more comprehensive view of water use behavior in the Virgin Islands, in that its scope was limited to only residential users of freshwater. Commercial users such as hotels, condominiums, laundries and car wash are intensive users and their use patterns should be determined and documented by means of a future study. Such a study should also determine the correlates of conservation among residential users.

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APPENDIX

Water Saving Devices

BATHROOM:

The Toilet

About 75 percent of the water used in households is in the bathroom, and a large proportion of this goes down the toilet. The average toilet uses five to seven gallons of water per flush.

There are several devices, homemade or commercial, that can reduce the amount of water used per flush. To work efficiently, there must be sufficient water in the tank to create pressure and a forceful flow. Bending the float arm will reduce the amount of water in the tank, but may make the flush inadequate. A plastic jug, weighted with clean rocks and water, will displace some water without reducing the water level. The top of the jug can be cut off to fit the space. Bricks or glass should not be used because fragments may get into the plumbing.

Weights, such as nuts or solder, placed on the flapper chain, will shut off the flow quickly as the handle is released. The handle can then be let go before the tank has fully emptied. Devices can be bought locally that allow for either a short or a long flush, according to need.
There are several types of low flush toilets that are currently on the market. Some of these use compressed air and as little as one half gallon of water per flush. Others use mineral oil instead of water.

Bathing

A shower or bath uses from 20-50 gallons. The ways to conserve water in the bath are to resist running the water, waiting for it to get hot, and to take shallow baths.

The shower head delivers from 5-15 gallons per minute. A washer placed in the pipe just behind the shower head will restrict the flow. Special shower-heads are available that restrict the flow to about three gallons per minute.

The sink faucet delivers about five gallons per minute. This can be cut down by installing an aerator.

Kitchen & Laundry

In the kitchen, apart from restricting the faucet flow, methods are more important than devices. Some dishwashers, if used only when they are full, use less water than some hand dish-washing methods. However, dishwashers are not common here.

The standard clothes washing machine uses from 25-55 gallons. Front-loaders use less than top -loaders. Modern machines have dials to regulate the amount of water according to the size of the load.

Garden

In the garden it is better to water less often, but soak the ground to about 2/3 the depth of the roots, and to use a trickle hose instead of a sprinkler. A moisture meter will tell when the soil is drying out, or a steel rod can be used; it will pass easily through wet soil but be stopped by dried soil.

Water Saving Methods

Much water can be conserved by using thrift methods. Letting the faucet or shower run to get water of a certain temperature is wasteful. If one must wait for the water to get hot, first flow can be collected in a bucket for other use.

When taking a shower, the bather should get wet, then turn off the water while soaping/washing, and turn it on again to rinse. This applies to tooth-brushing and shaving lso.

Unless the dish or clothes-washer has a volume control, it should be used only for full loads.

Check often for leaks and repair them quickly. Faucets that drip one drop per second waste 900 gallons per year, and a small steady stream wastes from 9,000 to 18,000 gallons per year. (Pratt, 1979).

Interviewer's Name _____ Date _____

STX [1], STT [2], STJ [3]
E.D. #: _____
Schedule #: _____

INTERVIEW SCHEDULE FOR PROPOSED STUDY OF FRESH WATER USE IN THE VIRGIN ISLANDS

Introduction: Good afternoon. My name is (your name). I work at the University of the Virgin Islands and your household has been chosen at random from the residents of the Virgin Islands to take part in an important study of how people use fresh water. You do not have to give your name and your answers will be kept strictly confidential. May we begin the interview?

Section A

I am first going to make a number of statements about water use in the Virgin Islands. Please tell me whether you strongly disagree, disagree, you are undecided, you agree or strongly agree with each one.

A-1 **Most people in the Virgin Islands waste fresh water.**

1. strongly disagree, **2.** disagree, **3.** undecided, **4.** agree
5. strongly agree, **0.** don't know, **9.** no response.... [ ]

A-2 **Fresh water is in abundant supply for everyone in the virgin Islands.**

1. strongly disagree, **2.** disagree, **3.** undecided, **4.** agree
5. strongly agree, **0.** don't know, **9.** no response.... [ ]

A-3 **Most people in the Virgin Islands have all of the fresh water that they need for home use.**

1. strongly disagree, **2.** disagree, **3.** undecided, **4.** agree
5. strongly agree, **0.** don't know, **9.** no response.... [ ]

A-4 **Most businesses in the Virgin Islands waste fresh water.**

1. strongly disagree, **2.** disagree, **3.** undecided, **4.** agree
5. strongly agree, **0.** don't know, **9.** no response.... [ ]

A-5 **Preserving our fresh water resources is an important issue in the Virgin Islands.**

1. strongly disagree, **2.** disagree, **3.** undecided, **4.** agree
5. strongly agree, **0.** don't know, **9.** no response.... [ ]

Section B

Now please answer the following questions directly.

B-1 **Where do you get most of the fresh water you use in your home?**

1. cistern, **2.** portable water (WAPA), **3.** private well, **4.** portable water (trucked), **5.** Cistern and Potable water, **0.** don't know, **9.** NR..... [ ]

(If you don't know or no response skip nos. B-2, B-3, B-4)

B-2 **Have you or your landlord purchased fresh water form a commercial hauler within the pat twelve months?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

(If no, skip B-3, B-4, and B-5)

B-3 **If yes, how many time a <u>year</u> do you and the landlord buy water from a commercial hauler?**

1. once, **2.** twice, **3.** three times, **4.** four or more times, **0.** don't know **9.** NR..... [ ]

B-4 **On an average, how much do you pay per year for water delivered by haulers?**

1. less than $60, **2.** $60-$120, **3.** $121-$180, **4.** $181-241, **5.** $242-302, **6.** $303 or more, **0.** don't know, **9.** NR.. [ ]

B-5 **Which one of the statements best describes how you feel about the cost of water you received from water haulers?**

1. very expensive, **2.** moderately expensive, **3.** neither expensive or cheap, **4.** moderately cheap, **5.** very cheap **0.** don't know, **9.** NR..... [ ]

B-6 **Do you or your landlord buy water from WAPA?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

(If no or don't know, skip B-7)

B-7 **If yes, how much do you or your landlord usually pay each month for water used in your home?**

$_____ monthly bill in dollars

0. don't know, **9.** NR..... [ ]

B-8 **What do you think about the cost of water received from WAPA?**

1. very expensive, **2.** moderately expensive, **3.** neither expensive or cheap, **4.** moderately cheap, **5.** very cheap **0.** don't know, **9.** NR..... [ ]

Section C

C-1 **How much time do you spend living in the Virgin Islands?**

1. year-round (permanent), **2.** during the winter months in the U.S. or elsewhere (temporary), **3.** during the summer months (temporary), **0.** don't know, **9.** NR..... [ ]

C-2 **About how long have you lived at your current address?**

1. less than 12 months, **2.** 1-10 years, **3.** 11-21 years, **4.** 22-32 years, **5.** 33+ years, **0.** don't know, **9.** NR.. [ ]

C-3 **Which one of the following best describes your living arrangements?**

1. renting, **2.** buying, **3.** own, **4.** other_____, **0.** don't know, **9.** NR..... [ ]

C-4 **Which one of the following best describes the place where you live?**

1. apartment, **2.** duplex/triplex, **3.** mobile home, **4.** single family dwelling, **5.** town house, **6.** condominium, **7.** public housing, **0.** don't know, **9.** NR..... [ ]

C-5 **Approximately how old is the place where you live?**

1. less than 12 months, **2.** 1-10 years, **3.** 11-21 years, **4.** 22-33 years, **5.** 33+ years, **0.** don't know, **9.** NR.. [ ]

C-6 **How many people live in your household?**

1. 1-2, **2.** 3-5, **3.** 6-8, **4.** 9 or more, **0.** don't know, **9.** NR..... [ ]

Section D

D-1 **Do you use a washing machine at home?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

D-2 **Do you or members of your household ever reuse fresh water after it has been previously used?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

(If no , skip D-3)

D-3 **If yes, which one of the following uses that you or members of your household make of water that has been previously used?**

1. toilet flush, **2.** wash car, **3.** wash dishes, **4.** other, **0.** don't know, **9.** NR..... [ ]

D-4 **What type of toilet system do you use in your home?**

1. the common white ceramic-type with hand lever, **2.** stainless steel with push button, **3.** low flush, **0.** don't know, **9.** NR..... [ ]

D-5 **On a daily average, how often is the toilet in your home flushed?**

_____ number of times

0. don't know, **9.** NR..... [ ]

D-6 **Which one of the following bathing activities do members of your household most often use?**

1. shower, **2.** tub bath, **3.** others_____, **0.** don't know, **9.** NR..... [ ]

D-7 **Do you or members of your household reuse water left from either the shower or tub baths?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

(If no, skip D-8)

D-8 **If yes, which one of the following uses that you and members of your household make of shower or tub water?**

1. toilet flush, **2.** wash car, **3.** wash dishes, **4.** other, **0.** don't know, **9.** NR..... [ ]

D-9 **Which one of the following most accurately describes your shower activity?**

1. apply soap while the shower is running, **2.** soak, turn off the faucet, apply soap then shower, **3.** run water until it gets warm, then soak, apply soap, then wash, **4.** other _____, **0.** don't know, **9.** NR. [ ]

D-10 **Is it a common practice for you and members of your household to leave the water running from the faucet while brushing teeth?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

D-11 **Is it a common practice for you and members of your household to leave the water running from the faucet while washing face?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

D-12 **Do you or a member of your household have at least one car?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

(If no, skip D-13, D-14)

D-13 **If yes, how many cars do you or members of your household have?**

1. one, **2.** two, **3.** three, **4.** don't have car, **0.** don't know, **9.** NR..... [ ]

D-14 **How often do you or members of your household wash the family car(s) with fresh water?**

1. don't wash family car(s), **2.** once per week, **3.** twice per week, **4.** three or more times a week, **5.** don't have a car(s), **0.** don't know, **9.** NR..... [ ]

D-15 **Which one of the following methods is most often used in cleaning your household laundry?**

1. commercial laundry, **2.** washing machine at home, **3.** wash by hand, **4.** other _____, **0.** don't know, **9.** NR.... [ ]

D-16 **If your laundry is cleaned at home, how many times per week are the clothes washed?**

1. at least once, **2.** twice, **3.** three or more times, **4.** don't clean laundry at home, **0.** don't know, **9.** NR..... [ ]

D-17 **What is the normal wash-load you must have before deciding to operate the washing machine?**

1. half-load, 2. full load, 3. less than half-load, 4. a few pieces of soiled laundry, 0. don't know, 9. NR..... [ ]

D-18 **Do you or members of your household wash their soiled laundry separately?**

1. yes, 2. no, 0. don't know, 9. NR..... [ ]

D-19 **Do you now have any leaking faucet in your home?**

1. yes, 2. no, 0. don't know, 9. NR..... [ ]

(If you don't have faucets, skip D-20)

D-20 **How long do you usually wait before having a leaking faucet fixed?**

1. sometimes up to one week, 2. several weeks, 3. months, 0. don't know, 9. NR..... [ ]

D-21 **How often do you hear a hissing sound in the back of your commode in your house?**

1. very seldom, 2. seldom, 3. sometimes, 4. frequently, 5. very frequently, 6. never, 7. don't have a commode in my house, 0. don't know, 9. NR..... [ ]

(If no commode, skip D-27)

D-22 **Do you cultivate a grass lawn, vegetable garden or flower garden?**

1. yes, 2. no, 0. don't know, 9. NR..... [ ]

(If no skip D-23)

D-23 **If yes, which one of the following indicates the frequency with which you water it?**

1. once a day, 2. every other day, 3. two days per week, 4. once a week, 5. every two or more weeks, 6. never water, 0. don't know, 9. NR..... [ ]

D-24 **Have you ever considered reducing the amount of fresh water your household uses?**

1. yes, 2. no, 0. don't know, 9. NR..... [ ]

D-25 **Do you have a low flow faucet in your house?**

1. yes, 2. no, 0. don't know, 9. NR..... [ ]

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D-27 **Do you now or have ever used toilet dams in your commode to save water when flushing?**

1. yes, **2.** no, **3.** don't have commode, **0.** don't know, **9.** NR..... [ ]

D-28 **Have you or members of your household washed dishes by hand?**

1. yes, **2.** no, **0.** don't know, **9.** NR..... [ ]

D-29 **Do you use a dishwasher to wash dishes?**

1. yes, **2.** no, **3.** don't have a dishwasher, **0.** don't know, **9.** NR..... [ ]

Section E

E-1 **What is the highest grade or years of school ever completed by the primary income earner?**

1. no schooling, **2.** elementary (1-6 yrs), **3.** Junior High, (7-8 yrs), **3.** Senior High (9-12 yrs), **4.** college (13-16 yrs), **5.** post-college (16+ yrs), **0.** don't know, **9.** NR [ ]

E-2 **To which of the following age groups do you belong?**

1. 18-25, **2.** 26-35, **3.** 36-45, **4.** 46-55, **5.** 56-65, **6.** 66 and over, **0.** don't know, **9.** NR..... [ ]

E-3 **What is the occupation of the primary income earner?**

1. managerial/professional/administrative, **2.** teacher/nurse/secretary, **3.** clerical/police, **4.** service occupation, **5.** laborer/construction/taxi driver/farmer/fish gatherer, **6.** homemaker/retired, **7.** unemployed, **8.** seasonally employed, **0.** don't know, **9.** NR..... [ ]

E-4 **To which of the following racial groups do you belong?**

1. black of Hispanic origin, **2.** black, **3.** white of Hispanic origin, **4.** white, **5.** Asian, **6.** other _____, **0.** don't know, **9.** NR..... [ ]

E-5 **What is the estimated value of the place where you live?**

1. less than $50,000, **2.** $51,000-76,000, **3.** $77,000-$102,000, **4.** $103,000-$128,000, **5.** $129,000-$154,000, **6.** $155,000-$180,000, **7.** $181,000-$206,000, **8.** $207,000 and more, **0.** don't know, **9.** NR..... [ ]

E-6 **Compared to other families in the Virgin Islands, how would you describe your family income?**

1. below average, **2.** about average, **3.** above average, **0.** don't know, **9.** NR..... [ ]