WATER USAGE PATTERNS IN THE U.S. VIRGIN ISLANDS

by

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ABSTRACT

A sample of residential and tourist dwelling units in the U.S. Virgin Islands was investigated to determine the per capita daily demand for residential water in a water deficient region. The sample was chosen to include a variety of types of occupants, all of whom enjoyed comfortable living, to determine water demand figures which can be used for future planning. The research demonstrated that high standards of living are currently achieved in the U.S. Virgin Islands by tourists and residents utilizing substantially less than forty gallons per capita per day for residential use. When tourists are removed from the sample, the average per capita daily demand drops below thirty gallons for residential use.

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INTRODUCTION AND OVERVIEW

The Territory of the U.S. Virgin Islands is composed of three main islands, St. Croix (84 sq. mi.), St. Thomas (28 sq. mi.), and St. John (20 sq. mi.), and more than 60 smaller islands and cays. The islands as a group receive an average of 40 inches of rainfall annually; however, about 90 percent of that rainfall is lost to evapotranspiration and the group of tropical, oceanic islands is classified as being semi-arid. The water resources, therefore, are scarce and generally of poor quality. Because of the limited scale of each island, there is no hinterland from which to draw additional resources.

Approximately 100,000 people live on the land area of 135 square miles. Most of the population rely directly on roof catchment and cistern storage of the inconstant rainfall for household water supplies.

The Territory experienced a period of phenomenal economical growth and population expansion during the 1960's and 1970's. The government invested heavily in sea water desalting plants in an attempt to relieve the chronic short supply of potable water created by the demands of a booming tourism-based economy. Temporarily successful in fulfilling the needs for potable water, by the mid-70's operational failures of the desalting equipment in combination with a continual reliance on inefficient and obsolete distribution systems and the meteorically rising price of energy made it impossible for the government to meet daily potable water needs, and a rationing schedule was imposed on public water supplies.

The current approach of the government toward solving the water problem involves repair of the distribution system and increasing the islands' desalting capacity to over eight million gallons per day. Success in this effort may prove financially devastating since current and projected pricing of pipeline-delivered desalted water involves a minimum government subsidy of ten dollars per one thousand gallons. This translates into a daily subsidy of $80,000 or an annual governmental outlay of almost $30 million.

In light of these high cost levels associated with the water supply it has become imperative that the demand side of the water picture be more closely examined. How much water do islanders use? Who uses what kind of water for what purposes? And how much is really needed?

One important figure is domestic or household water usage or demand. This water is used mostly for bathing, sanitary flushing, laundry, dishwashing, cooking, cleaning and drinking.

A 1500 square foot roof will collect roughly 37 inches of rain in a normal island rainfall year which converts to a supply of about 100 gallons per day. The fact that many Virgin Islanders depend totally on cistern water for residential supply allows us to ask the simple question, "What are their water use patterns and is this usage consistent with high standards of living?"

To answer this question, the Water Resources Research Center of the Caribbean Research Institute, College of the Virgin Islands, through a grant from the U.S. Department of Interior, Office of Water Research and Technology initiated this water usage patterns project.

OBJECTIVES

The project was intended to develop original data on the water usage patterns of a small sample of dwelling units occupied by a variety of residents and tourists and to analyze that data in order to provide useful per capita demand figures for residential water in light of increasing water supply costs.

SCOPE

The installation of water measuring instruments on a sample of island dwelling units, in combination with a monitoring program provided the opportunity to obtain original water usage data on 1790 dwelling unit days involving the domestic usage of 5900 people days. The test period started in November 1979 and ended in July 1980. The major categories of water users for which data were collected were tourists, residents of island origin and resident continentals. Existing data of lower reliability were obtained on two condominium complexes and three public housing projects.

APPROACH AND METHODS

Fourteen dwelling units were selected for the original data sample. One unit was eventually dropped from the sample because the technique used to measure water usage could not be applied to that unit without the introduction of large measurement errors. The strategy for the selection of tests sites involved a number of considerations.

All sites represented dwellings occupied by persons who could afford to purchase additional water if they wished to but had seldom or never done so. All but one of the sites were owner occupied. None of these dwellings were dependent on piped or desalted water. More than 90% of the water used was supplied by rainfall even though more than 85% of the dwellings were located in the driest areas of the islands. It is believed that this strategy has provided a sample of occupants that neither wastes water nor allows the shortage of water to infringe on their standards of living. The selection of tourist sites involved finding locations on or near the beaches and away from town or other attractions such that almost all of the tourist water consumption would show up as dwelling usage. The break between continental and island origin was mandated by the contention that islanders have a long tradition of being very careful with potable water.

Two of the dwellings had dual water systems. For toilet flushing one used seawater and the other used highly brackish well water.

Two of the dwellings included one room rental units with baths. The water usage for these units was included as part of the main dwelling unit as were the occupants.

It should be noted that the vast majority of the occupants in the tourist sample were not responsible for the cost of the water they used other than the fact that the renter rate may or may not reflect the cost of providing water during a typical tourist season. Toward the end of the test period one of the tourist sites was rented to a resident who was responsible for the cost of purchased water if it became necessary. That is, if the cistern supply was exhausted the renter was obliged to purchase a truckload of water at a cost of $20 per thousand gallons. As a result there was a substantial reduction in per capita consumption and the site was changed from a tourist site to a resident site.

Already existing data on public housing projects and condominiums was collected on the basis that it was available, that it appeared to be reasonable correct and that during the monitored periods major interruptions in the supply of water had not occurred.

In the interest of developing a low-cost method by which island homeowners could measure their water consumption, a novel system was devised and used in this project. Instead of a high-cost water meter installation, a cheap electrical clock was attached to the pressure switch of the water pressurization systems in such a manner that the clock ran only when the water pump was running. then by the use of a potable water meter or a measuring pail a clock factor was determined for each pump installation which converted pump running time into gallons of water pumped. This calibration factor was repeatedly checked and adjusted throughout the test period. This technique provided reasonably accurate data although it does have some drawbacks. Errors introduced by this technique are discussed in a later section of this report. Almost all errors introduced by this technique tend to overestimate the water usage. Thus, the figures presented in this report may be slightly higher than the actual per capita usage.

Once the initial clock installations and calibration had been completed, each site was visited on a periodic basis to obtain the number of gallons used, the number of people days involved, any changes in the site characteristics, explanations from the occupants as to the reasons for any major changes in the per capita daily water usage, and assurance that the measurement technique was operating properly. The monitoring period began in November of 1979 and ended in July of 1980. The number of visits to each test site varied widely depending on a number of factors. Tourist dwellings often required weekly or even daily visits to maintain records of the changing number of occupants involved with short-term vacation rentals. In all, almost two hundred site visits were performed to provide 1790 unit test days of usable data.

RESULTS AND DISCUSSION*

As originally intended, this project has produced a sizeable volume of data. This data is presented in Table I - Table XXIV. It is hoped that this data will provide a source of information for further analysis by others.

The major results of this project are presented in Tables I and II. It should be remembered that these figures represent residential or domestic water usage only and do not include other water usage such as school needs, medical needs, workforce needs, hotel needs, day visitor needs, agricultural needs, etc.

Additionally, because of the small sample and the judgmental nature of its selection, no contention is made by this project that the figures presented truly represent the current residential demand or usage of water. However, it is the contention of this project that these water usage figures are consistent with levels of usage for high standards of living in the Virgin Islands. These usage figures will provide useful planning figures once it is generally realized that the Virgin Islands water problems cannot be economically solved in the long run merely by increasing the supply of costly desalted seawater.

The results presented in Tables I and II are self-explanatory and show reasonable consistency with the exception of the mean and the adjusted mean for the total sample. When the mean by dwelling units was adjusted by weighting those means by the number of people days involved, the usage for the total sample dropped from 35.65 to 29.23 gallons per day per person. The reason for this is that while the residents of island origin made up only 43% of the dwelling test sites, they constituted over 55% of the total sample of people days. It is believed that the lower figure represents the residential usage which could be achieved by reasonable conservation methods for the islands as a whole without infringements on anyone's standard of living.

Site Characteristics

Site characteristics for each of the dwelling units are included in Table I The composite site characteristics for the total sample were as follows:

a. The average number of occupants was 3.3.
b. The average number of bedrooms was 2.9.
c. The average number of bathrooms was 2.2.
d. 79% had laundry washing machines.
e. 21% had dish washing machines.
f. 7 % had swimming pools.
g. None used significant amounts of water for irrigation.
h. None had garbage disposal machines.

* Tables referred to may be found in the Appendix

Subpotable Water

Of particular interest were the two dwelling units that used subpotable water for flushing. (Table XIV and Table XV) One site,T4, was the highest user of water in the total sample with an average usage of 71 gallons per capita per day; however, of this amount 20 gallons or 28% was highly brackish well water used for toilet flushing and available, but not used significantly, for outside irrigation. The other unit, site RIC using seawater for flushing only used a total average of 34 gallons per capita per day. At this unit, 13 gallons of the usage or 38% was provided by seawater, thus lowering the household usage of potable water to 21 gallons per capita per day. Although the sample is too small, it does tend to suggest that a quarter or more of the Virgin Islands residential water demand could be met with low cost seawater, brackish or gray water. If this is a possible option, then the residential demand for potable water would drop to below 20 gallons per capita per day. Based on average rainfall and catchment potential this 20 gallons per day can be obtained by approximately 300 square feet of roof top catchment per capita.

Two sections of a large condominium were examined to determine their level of water usage (Table VIII and Table IX). In both this section of the report and in the raw data summary section figures presented do not include toilet flushing since gray water is used for this purpose and no measurement is made of that water.

The manager of this 102-unit complex reported that its highest water consumption occurred in January of 1980 and that the rate for that month was 11,000 gallons per day or 108 gallons per unit per day. He estimated the total occupancy during that period at 400 to 500. If he was correct the gallons per day per perosn was in the range of 22 to 27.5

Our investigation of 20 units in two sections of the complex provided metered data covering the period of January 1, 1980 to May 30, 1980. Our occupant figures covered only the occupants of the units who were permanent residents and did not include their guests. For one condominium section containing 12 units, the gallons per person per day figures were as follows: a mean of 31.4, a range of 14 to 51, and a standard deviation of 11.4. For the other section containing 8 units the figures were; a mean of 45.4, a range of 22 to 83, and a standard deviation of 19.8. The combined mean for the two sections based on the number of people days was 36.77. Again, it must be remembered that this figure does not include guests or sanitary flushing water. The cost of this water to these year round residents is $15 per thousand gallons.

Public Housing Projects

Because of frequent water shortages and non-functional water meters it is difficult to obtain accurate data on the water usage of public housing projects. After an extensive search of the records it was possible to identify three projects on the island of St. Croix that had not experienced major water shortages during various periods in the years 1978 and 1979, and where some meter readings were available. The data presented both in this section of the report and on the raw data summary, Table X, include

only water delivered to the projects by the public water pipeline and do not include water obtained from rooftop rain catchments. If the catchments were functioning, calculations indicate that another 4.5 to 5 gallons per person per day should be added to the usage figures presented. Combining the total gallons delivered and the total number of people days involved in all three projects, the mean gallons per person per day was 97 based on over 27 million gallons delivered via the pipeline. The average for the three projects taken on a "by project" basis was 89. The range was 70 to 112. Though these numbers may seem high they are in agreement with most other estimates that have been examined.

There appear to be at least three reasons for these high usage figures. First, it is believed that the population figures for the projects may be lower than the actual number of occupants living in the projects. Secondly, it is stated by the public housing maintenance personnel that many of the projects have serious leakage problems within the project's own distribution systems. Third, and probably the most important reason, is that the occupants are not responsible for paying for the water which they use.

As can be seen from the original data developed by this study, when the occupant is not responsible for the cost of his water consumption the usage drastically increases. For instance, tourist consumption averages 62 gallons per capita per day, while that of residents who are responsible for the cost of their water is only about 25 gallons. Another example is a tourist dwelling unit which was converted to a resident unit with the renter responsible for the cost of water. Under these circumstances the average usage on a per capita bais dropped from 67.5 to 30.8. This was the same house; the only thing that really changed was the incentive to reduce water usage. These are not isolated instances. When owners of tourist vacation rental units arrive the water usage almost invaribale decreases drastically.

SOURCES OF POSSIBLE ERRORS

Measurement errors are an inherent part of any effort to develop original data. The water measuring technique used in this project does contain a number of factors which can lead to non- quantifiable errors. However, the application of this technique leads us to believe that all of the factors that caused errors with the exception of one, caused high side errors. That is, the vast majority of the errors introduced made the figures presented in this report slightly higher than the actual water usage. For example, the test period began during a rainy December which included such factors as cisterns overflowing at every test site, high Christmas and school vacation usage and the end of a two-year period of the highest rainfalls on record. Due to the previous heavy rainfalls and overflowing cisterns it can be reasonably speculated that water conservation by the sample of occupants was not an all-time high.

One owner mentioned, "We can make the last quarter of our cistern supply last about as long as the first three quarters." Although this may be an exaggeration, the overall data did indicate a slight decrease in water usage as the test period moved into less rainy periods.

The pump running time technique used can introduce serious errors if the foot valve in the cistern leaks. In that case, water in the pressure tank leaks back into the cistern causing the pump to run periodically even when no water usage has occurred. The one test site that was dropped from the sample was dropped because of this problem. The remaining sites were monitored for this problem, and the extent to which it may have occurred without detection would have caused water usage readings higher than the actual usage.

Several of the sites included systems which periodically experienced the problem of water bound pressure tanks which caused frequent starts and stops of the pump. When this condition was encountered it was immediately repaired. However, the error that may have been introduced by these situations was again an error tending to make the presented figures higher than the actual usage.

Another possible source of error which would make the presented figures higher than the actual usage is that of the calibration technique used. Since the majority of pumps used at the test sites were centrifugal types, the amount of water pumped during a fixed pumping time can decrease substantially with a lowering of the net positive suction head(NPSH). Thus, as the level of water in the cistern goes down, these types of pumps will pump less water due to a decreasing NPSH. To accommodate for this, each pump of this type was periodically recalibrated. However, since the entire test period started with high cistern levels and ended with low cistern levels the recalibration tended to lag the actual lowering of the NPSH, thus possibly introducing another slight high side of error.

The only error which could cause the figures presented to be lower than the actual usage was long-term running of the pumps at a full flow levels such as might be encountered in filling a swimming pool. In this case, the average pressure encountered by the centrifugal pump would be less than the average on and off cycle pressure which was used to calibrate the pump. Under such conditions the water usage could be higher than the measurement indicated by the clock. Since only one test site involved the filling of a swimming pool, requiring approximately 500 gallons per week, it is believed that this factor did not introduce substantial errors into the figures presented.

Overall, the measurement technique used was sufficiently accurate to pick up such items as a slow leak in a toilet, leaking foot valves and a school-aged child home sick with diarrhea

CONCLUSIONS AND OBSERVATIONS

The major conclusion of this project is that high standards of living can be maintained in the US Virgin Islands with an average domestic water usage of less than 40 and perhaps as low as 30 gallons per person per day.

Observations show that residential water usage can be cut at least in half if the occupants have sufficient economic incentives to conserve water.

It is also observed that residents of island origin are more conservative of domestic water usage than residents of continental origin if sufficient financial incentives exist to conserve. It appears that occupants of public housing projects tend to use more water than even tourist when economic incentives to conserve are removed from both groups.

RECOMMENDATIONS

1) The Government of the Virgin Islands should shift its long-term emphasis on the water supply side to the water demand side of the water shortage problem.

2) All investment in increasing the supply of water in the island should be viewed in the light of potential long-term benefits associated with an equal investment in reducing the demand for water.

3) An economic analysis of the potential benefits of increasing the supply of subpotable water should be initiated.

4) The Government of the Virgin Islands should develop and implement a public information campaign which would stress the cost effectiveness of conserving water and reducing usage by all individuals and facilities in the Territory

5) The Virgin Islands Housing Authority should develop and test a variety of innovative financial incentives to reduce water usage in its projects. The potential for decreasing eventual water demand is over one million gallons per day in these living areas.

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APPENDIX

T A B L E I

Summary of Project Results

(gallons per capita per day)

Occupants	Mean [a]	Mean [b]	Range	Standard Deviation (using n - 1)
Tourists	61.98	61.72	42 - 71	13.51
All Residents	25.12	22.90	10 - 49	12.98
Residents of Island Origin	16.13	14.74	10 - 23	4.54
Residents of Continental org.	38.61	38.94	31 - 49	8.20
Total Sample	35.65	29.23	10 - 71	21.39

a Mean based on dwelling units.

b Mean weighted for number of people days.

T A B L E II

Summary of Site Characteristics

and Results

Site Number	T1	T2	T3	T4	R1C	R2I	R3I	R4I	R5I	R6I	R7I	R8C	R9C	R10C
Bedrooms	3	2	2	3	3	4	3	3	3	4	2	3	3	3
Bathrooms	3	2	2	3	2	3	2	1	1	2	2	3	3	3
Children	0	0	0	0	1-4	3	0	0-2	2	1-3	0	0	0	2
Swimming Pool	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes
Extensive Gardening	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Washing Machine	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes
Dish Washer	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Occupant[a]	V	V	V	T	O	O/R	O	O	O	O	O/R	R	O	O
Origin[b]	C	C	C	C	C	I	C	I	I		I	C	C	C
Water Consumption[c]														
Mean	66.6	63.3	44.4	73.0	32.2	15.0	18.0	15.1	9.3	17	25	32.8	47.6	40.2
Range	53-77	42-87	25-81	65-80	21-44	19-17	14-26	11-23	8-13	13-24	10-46	24-58	32-57	29-60
Std. Deviation	11.3	18.7	19.7	7.6	7.3	1.7	3.7	3.6	2.0	4.2	12.4	14.5	6.53	10.2

a. O: Owner R: Rental T: Tourist V: Variable

b. C: Contintental I: Islander

c. In gallons per capita per day. Mean not weighted for number of people days.

T A B L E III

Raw Data Summary For
Total Sample

Site Number	Number of Test Days	Gallons Used	Number of Occupants	Number of People Days	Gals/Pers/ Day
R1C	151	22,060	4.4	657	33.58
R2I	81	8,174	7.0	567	14.42
R3I	209	7,953	2.0	418	19.03
R4I	216	7,315	2.2	470	15.56
R5I	195	7,095	4.0	780	9.77
R6I	197	11,362	3.9	764	14.87
R7I	138	6,343	2.0	274	23.15
R8C	45	2,984	2.2	97	30.76
R9C	143	14,710	2.1	300	49.03
R10C	140	25,048	4.4	610	41.06
T1	83	26,802	4.8	397	67.51
T2	79	14,555	2.7	217	67.01
T3	67	9,728	3.5	232	41.93
T4	46	8,356	2.5	117	71.42
					35.65
Totals:		172,485		5,900	29.23 #

Mean weighted for number of people days.

Mean: 35.65 Range: 10-17 Std. Dev: 21.39

TABLE IV

Raw Data Summary For
Tourist Sample

Site Number	Number of Test Days	Gallons Used	Number of Occupants	Number of People Days	Gals/Pers/ Day
T1	83	30,802	4.6	497	67.51
T2	79	14,555	2.7	217	67.07
T3	67	9,728	3.5	232	41.93
T4	46	8,356	2.5	117	71.42
					61.98
Totals:		59,441		963	61.72 #

Mean weighted for number of people days.

Mean: 61.98 Range: 42-71 Std. Dev: 13.51

TABLE V

Raw Data Summary For
All Residents

Site Number	Number of Test Days	Gallons Used	Number of Occupants	Number of People Days	Gals/Pers/ Day
R1C	151	22,060	4.4	657	33.58
R2I	81	8,174	7.0	567	14.41
R3I	209	7,953	2.0	418	19.03
R4I	216	7,315	2.2	470	15.56
R5I	195	7,095	4.0	780	9.77
R6I	197	11,362	3.9	764	14.87
R7I	138	6,343	2.0	274	23.15
R8C	45	2,984	2.2	97	30.76
R9C	143	14,710	2.1	300	49.03
R10C	140	25,048	4.4	610	41.06
					25.12
Totals:		11,044		4,937	22.89 #

Mean weighted for number of people days.

Mean: 25.12 Range: 10-49 Std. Dev: 12.98

TABLE VI

Raw Data Summary For

Residents of Island Origin

Site Number	Number of Test Days	Gallons Used	Number of Occupants	Number of People Days	Gals/Pers/ Day
R2I	81	8,174	7.0	567	14.42
R3I	209	7,953	2.0	418	19.03
R4I	216	7,315	2.2	470	15.56
R5I	195	7,095	4.0	780	9.77
R6I	197	11,362	3.9	764	14.87
R7I	138	6,343	2.0	274	23.15
					16.13
Totals:		48.242		3,273	14.74 #

Mean weighted for number of people days.

Mean: 16.13 Range: 10-23 Std. Dev: 4.54

TABLE VII

Raw Data Summary For

Residents of Continental Origin

Site Number	Number of Test Days	Gallons Used	Number of Occupants	Number of People Days	Gals/Pers/ Day
R1C	151	20,060	4.4	657	33.56
R8C	45	2,984	2.2	97	30.76
R9C	143	14,710	2.1	360	49.03
R10C	140	25,048	4.4	610	41.96
					38.61
Totals:		64,802		1,664	38.94 #

Mean weighted for number of people days.

Mean: 38.61 Range: 31-49 Std. Dev: 8.2

TABLE VIII

Raw Data Summary For

Condominium No. 1

Unit Number	Number of Test Days	Total Gallons Used	Gallons Used Per Day	Persons Per Day*	Number of People Days	Gallons Per Persons Per Days ƒ
1	152	4,406	29	2	304	14.97
2		6,080	40	1	152	40.13
3		23,256	153	4	606	38.32
4		3,444	22	1	152	22.37
5		7,752	51	2	304	25.33
6		9,728	64	2	304	32.23
7		8,056	53	2	304	26.64
8		8,664	57	2	304	28.29
9		15,504	102	2	304	50.99
10		10,944	72	2	304	35.86
11		9,728	64	4	606	15.96
12	152	21,128	139	3	456	96.27
						31. 4
Totals:		128,592			4,100	31. 4 #

Mean weighted for number of people days.

* Includes permanent residents ;not visitors to units.

ƒ Does not include gray water flushing.

Mean: 31.4 Range: 41-51 Std. Dev.: 11.38

TABLE IX

Raw Data Summary For

Condominium No. 2

Unit Number	Number of Test Days	Total Gallons Used	Gallons Used Per Day	Persons Per Day*	Number of People Days	Gallons Per Person Per Day ƒ
1	152	11,552	76	2	302	38.16
2		10,184	67	2	302	33.55
3		19,912	131	2	302	65.46
4		25,232	166	2	302	83.22
5		6,840	45	2	302	22,37
6		20,064	132	3	456	43.86
7		13,680	90	2	302	45.07
8	152	9,728	64	2	302	31.91
						45.45
Totals		117,192			2584	45.35 #

Mean weighted for number of people days.

* Includes permanent residents;not visitors to unit

ƒ Does not include gray water flushing.

Mean: 45.45 Range: 22-83 Std.Dev.: 19.79

T A B L E X

Raw Data Summary For

Public Housing Projects

	Period of Record	Duaration	Gallons used (x 1000)	Number of Occupants	Number of People Days	Gal/Pers/Day
Project #1	June 1978 to July 1979	365	18,478	452	164,980	112
Project # 2	July 1978 to August 1979	365	3,987	127	46,355	86
Project # 3	Sept. 1979 to Nov. 1979	61	4,684	1,097	66,917	70
Totals		791	27,149		278,252	89.3 / 97.6#

Mean weighted for number of people days.

Note : Data based on published population figures and billings by the Department of Public Works.

Mean: 89.3 Range: 70-112

TABLE XI

Raw Data Summary For

SITE T1

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 22	14	1,521	109	2	28	54
30	8	2,980	372	5	40	75
1980						
Jan. 20	21	7,488	357	5	105	71
27	6	2,412	245	6	36	57
Feb. 2	6	2,358	393	6	33	71
9	7	2,544	363	6	42	60
20	11	4,686	426	6	66	71
Mar. 1	7	2,030	290	5	38	53
21	3	783	261	3	9	87
						66.56
Totals:		26,802			397	67.51 #

Mean weighted for number of people days.

Note: Tourist occupancy ended on March 21. Record continued as SITE R8C, Table XXII.

Mean: 66.56 Range: 53-87 Std. Dev.: 11.31

TABLE XII

Raw Data Summary For

SITE T2

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 31	14	1,323	94	2	28	47
1980						
Jan. 20	20	5,230	261	3	60	87
28	8	702	88	2	17	42
Feb. 9	10	2,678	223	4	36	70
19	10	1,841	184	4	40	46*
Mar. 1	10	1,863	169	2	20	85
8	7	918	131	2	14	66
						63.29
Totals:		14,555			217	67.07 #

Mean weighted for number of people days.

* Occupied by owner

Mean: 63.29 Range: 42-87 Std. Dev.: 18.72

TABLE XIII

Raw Data Summary For

SITE T3

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1980						
Jan. 27	17	4,268	251	6	104	41
Feb. 2	6	418	70	2	12	35
9	7	682	97	2	14	49
20	11	1,782	162	2	22	81
Mar. 1	10	1,100	110	2	20	55
8	7	594	84	3	24	25*
17	9	884	98	4	36	25*
						44.43
Totals:		9,728			232	41.93 #

Mean weighted for number of people days.

* Occupied by owner.

Mean: 44.43 Range: 25-81 Std. Dev.: 19.69

TABLE XIV

Raw Data Summary For

SITE T4

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 30	7	2,230	318	4	28	80
1980						
Feb. 5	16	2,213	138	2	34	65
20	11	1,686	153	2	26	65
Mar. 8	7	1,585*	226	3	21	75
13	5	642*	128	2	8	80
						73.0
Totals:		8,356			117	71.42 #

Mean weighted for number of people days.

. Brackish well water used for flushing. This Table supplemented by Tables XIV -A and XIV - B

* Includes flushing based on mean record rather than actual measurement.

Mean: 73.0 Range: 65 - 80 Std. Dev.: 7.58

TABLE XIV -A

Raw Data Summary For

Potable Water Usage at Site T4

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 30	7	1,365	195	4	28	49
1980						
Feb. 5	16	1,617	101	2	34	48
20	11	998	91	2	26	38
Mar. 8	7	1,165	166	3	21	55
13	5	482	96	1	8	60
						50.0
Totals:		5,627			117	48.12

* Mean weighted for number of people days.

Mean: 50.0 Range: 38-60 Std.Dev.:8.28

TABLE XIV -B

Raw Data Summary For

Brackish Water Usage at Site T4*

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 30	7	865	124	4	28	31
1980						
Feb. 5	16	596	38	2	34	18
9	4	297	62	3	14	18
20	11	688	62	2	26	26
Mar. 1	5	456	91	8	40	11
						20.80
Totals:		2,852			142	20.18

* Mean weighted for number of people days.

* Brackish well water is used for flushing

Mean: 20.90 Range: 11-31 Std. Dev.: 7.79

TABLE XV

Raw Data Summary For

SITE R1C

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 8	8	989	124	4	32	31
22	14	1,492*	107	3	42	36
30	8	2,322*	290	7	58	40
1980						
Jan. 24	25	4,554*	182	4	108	42
Feb. 2	9	1,576	175	4	36	44
7	5	809	162	6	30	27
16	9	1,437	160	4	36	40
28	14	1,196*	85	4	56	21
Mar. 7	8	367	46	2	16	23
16	9	1,394	155	5	45	31
22	6	568	95	4	24	24
Jun. 7	7	1,060	151	5	35	30
17	10	1,546	155	5	50	31
Jul. 6	19	2,750	145	5	89	31
						32.21 #
Totals:		22,060	151			33.58

Mean weighted for number of people days.

* Includes seawater used based on seawater mean rather than actual measurement.

Mean: 32.21 Range: 21-44 Std.Dev.: 7.27

TABLE XV - A

Raw Data Summary For

Potable Water Usage at Site R1C

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 9	8	746	93	4	32	23
22	14	946	68	3	42	23
30	8	1,568	196	7	56	27
1980						
Jan. 24	24	3,150	126	4	108	29
Feb. 2	9	941	105	4	36	26
7	5	429	86	6	30	14
16	9	577	64	4	36	16
28	14	468	39	4	56	10
Mar. 7	8	221	28	2	16	14
16	9	676	75	5	45	15
22	6	192	35	4	24	8
Jun. 7	7	655	94	5	35	19
17	10	906	91	5	50	18
Jul. 6	19	1,942	102	5	89	22
						18.86 #
Totals:		13,417			657	2,042

Mean weighted for number of people days.

Mean: 18.86 Range: 8 - 29 Std. Dev.: 6.4

TABLE XV - B

Raw Data Summary For

Seawater Usage at Site R1C

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 8	8	243	30	4	32	8
1980						
Feb. 2	9	635	71	4	36	18
7	5	380	76	6	30	13
16	9	860	96	4	36	24*
Mar. 7	8	146	18	2	16	9
16	9	718	80	5	45	16
22	6	376	63	4	24	16
Jun. 7	7	405	58	5	35	12
17	10	640	64	5	50	13
Jul. 6	19	808	42	5	89	9
						13.8
Totals:		5,211			393	13.26 #

Mean weighted for number of people days.

* Child home with illness

Mean: 13.8 Range: 8 - 24 Std. Dev.: 4.89

TABLE XVI

Raw Data Summary For

Site R2I

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1980						
Feb. 12	38	3,474	94	7	266	14
Mar. 11	28	3,252	116	7	196	17
26	15	1,448	96	7	105	14
						15.0
Totals:		8,174			567	14.42 #

Mean weighted for number of people days.

Mean: 15.0 Range: 14-17 Std.Dev.: 1.73

TABLE XVII

Raw Data Summary For

Site R3I

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1980						
Jan. 21	44	2,331	53	2	88	26
Feb. 8	18	504	28	2	36	14
18	10	354	35	2	20	18
Mar. 3	14	560	40	2	28	20
17	14	511	36	2	28	18
May 21	65	2,257	35	2	130	17
Jun. 4	14	363	26	2	28	13
16	12	455	40	2	24	19
Jul. 4	18	618	34	2	36	17
						18.0
Totals:		7,953			418	19.03 #

Mean weighted for number of people days.

Mean: 18.0 Range: 14-26 Std. Dev.: 3.74

TABLE XVIII

Raw Data Summary For

Site R4I

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 4	20	912	46	2	40	23
24	12	665	57	4	48	14
1980						
Feb. 12	38	1,163	31	2	76	15
27	15	342	23	2	30	11
Mar. 12	16	433	33	2	32	17
26	12	475	34	2	24	17
May 28	63	2,185	35	2	126	17
Jun. 10	12	315	26	2	24	13
24	14	331	24	2	28	12
Jul. 8	14	494	35	3	42	12
						15.1
Totals:		7,315			470	15.56 #

Mean weighted for number of people days.

Mean: 15.1 Range: 11-23 Std. Dev.: 3.57

TABLE XIX

Raw Data Summary For

Site R5I

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 31	5	222	44	4	20	11
1980						
Jan. 5	5	203	41	4	20	10
Feb. 12	38	1,436	39	4	152	10
27	15	443	30	4	60	7
Mar. 12	14	678	52	4	56	8
24	12	452	32	4	48	8
May 28	65	2,124	33	4	260	8
Jun. 10	13	452	35	4	52	9
24	14	520	37	4	56	9
Jul. 8	14	565	40	4	56	10
						9.3
Totals:		7,095			780	9.77 #

Mean weighted for number of people days.

Mean: 9.3 Range: 8-12 Std. Dev.: .2

TABLE XX

Raw Data Summary For

Site R6I

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 31	7	532	76	5	35	15
1980						
Feb. 12	43	2,447	57	4	172	14
27	15	783	52	4	60	13
Mar. 26	28	1,748	62	4	112	16
May 28	63	3,192	51	4	262	13
Jun. 10	13	722	56	3	39	19
29	14	912	65	3	42	22
Jul. 8	14	1,026	73	3	42	24
						17.0
Totals:		11,362			764	14.87 #

Mean weighted for number of people days.

Mean: 17.0 Range: 13-24 Std. Dev.: 4.21

TABLE XXI

Raw Data Summary For

Site R7I

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1979						
Dec. 31	27	920	34	2	54	17
1980						
Jan. 20	20	874	44	2	40	22
Feb. 13	23	1,403	61	2	46	30
Mar. 12	28	570	20	2	54	10
26	14	1,288	92	2	28	46
Jun. 24	26	1,288	50	2	52	25
						25. 0
Totals:		6,343	274			23.15

* Mean weighted for number of people days.

Mean: 25.0 Range: 10 - 46 Std. Dev.: 12.36

TABLE XXII

Raw Data Summary For

Site R8C*

Date of Reading	Number of Test Days	Total Gallons Used	Gallons Used per Day	Persons per Day	Number of People Days	Gallons per Person per Day
1980						
May 30	12	702	58	1	12	58
Jun 6	7	680	96	3	21	32
7	1	88	88	3	3	24/
14	7	469	67	3	19	25
Jul 2	18	1,055	59	2	42	25
						32.8
Totals:		2,984			97	30.76

* Mean weighted for number of people days.

* Continuation of Table XI but now occupied by residents.

/ 30 hour test period

Mean: 32.8 Range: 24-58 Std.Dev.: 14.45