SMALL SCALE WASTE MANAGEMENT PROJECT

UNIVERSITY OF WISCONSIN–MADISON

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Water Use in Rural Homes

by

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(27 pages.)

The Small Scale Waste Management Project developed in response to the need for safe, reliable and economic alternative treatment and disposal systems for small wastewater flows in unsewered areas.

The Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, has been working on the problem since 1969, with initial support from the Wisconsin Department of Natural Resources. The Upper Great Lakes Regional Commission has provided funding to the University of Wisconsin-Extension since July, 1971 for test demonstrations of on-site wastewater and disposal systems. Special research funds were appropriated by the State of Wisconsin in November, 1971 to the College of Agricultural and Life Sciences, University of Wisconsin-Madison to develop solutions to the problem. Additional funds were granted to the Water Resources Center, University of Wisconsin-Madison in December, 1973. The Small Scale Waste Management Project grew out of an integration of these activities.

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Abstract

A study of eleven rural homes was conducted to determine the contributions made to the volume of wastewater on a day-to-day basis and on an hourly basis. High and low flows and changes in flow patterns from summer to winter were also examined. To obtain the desired information, monitoring of the flows was accomplished by using a chart recorder attached to the water meter which recorded flow and time of water use in a home. The water use was assigned to six events: (1) Toilet, (2) Laundry, (3) Bath or Shower, (4) Dishes, (5) Water Softener, and (6) Other. These events and the volumes were then identified from the charts, tabulated, and analyzed.

Data was collected for a total of 434 days at the eleven households. At three sites, water use was monitored during both the winter and summer seasons. The analysis of the data allowed the determination of average values of usage in gallons per capita per day and the calculation of 90% confidence intervals. The average size and the frequency of the events were also determined. From this information, possible flow reductions by the use of various water saving techniques were estimated for each home in the study.

OBJECTIVES AND SCOPE

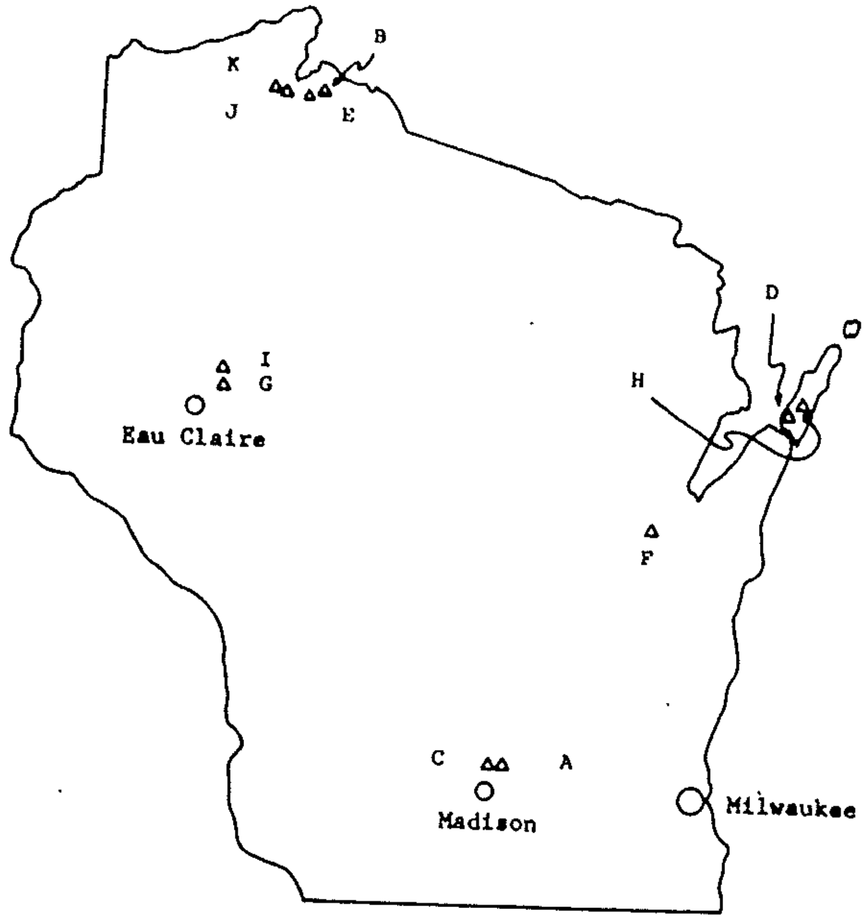
Soon after the initiation of studies to develop alternative on-site treatment and disposal alternatives for rural homes in problem soil areas it became evident that more information was needed to characterize the volume and quality of waste generated from the home, the events which contribute to the flow, and the patterns or variations in the flow which a treatment system might receive. Based on these needs a program was designed to characterize wastewater flows. Four chief objectives were established for the study. The first was to study the contributions made to the volume of wastewater from the various events in a home on a day-to-day basis. This information would show any patterns of usage or differences between one day of the week to the next. The second objective was to study the usage patterns through the day on an hourly basis. With this information, periods of high or low flow could be identified as well as the frequency of the various events contributing to the flow. The third objective was to look at changes in the flow patterns from winter to summer seasons. The fourth was to look for simple methods of reducing the flow in the sample homes and predicting what the water savings might be.

This study was planned to include many of the sites which were presently involved with the Small Scale Waste Management Project (SSWMP) and any additional sites which could easily be included in the study to give a wide variety of family sizes and types. Of the sites available, eleven were chosen for study. It was felt that the sample period should be of sufficient length to adequately characterize the flow in each home. Also it was determined data should be in such form that it could easily be compared to previous studies reported in the literature.

Efforts were made to obtain approximately four weeks or more of data at each site with the data being collected in segments no smaller than seven continuous days. Winter to summer comparisons were made at only three of the eleven sites with at least five weeks of summer data and four weeks of winter data at each site. Time did not permit further winter-summer studies. Precautions were also taken to introduce as little bias as possible by the homeowner. This was done by minimizing the homeowner's involvement in the collection of data.

PROCEDURES

Eleven sites were monitored during this study, nine of which are also involved in the SSWMP study of disposal systems. The additional two sites were both easily accessible due to their proximity to other sites and were thus included. The locations of the sites are shown in Figure 1. These sites offered a wide variety of family types and sizes. A summary of the family information is shown in Table 1. It was felt by including a large sample of homes, the information collected would give more representative results of a rural population.



LOCATION OF SITES

Figure 1

Many problems arise when trying to develop a method of monitoring the water usage in a home. Since flow pattern is sometimes very closely related to the family life style, cooperation of the participants was of the utmost importance. The second major concern was to conduct the survey in such a way as not to bias or change the normal patterns of the family. It would be ideal if the study could be conducted

TABLE 1

FAMILY INFORMATION

LOCATION	ADULTS	CHILDREN (AGE)	BATHROOMS	AUTOMATIC CLOTHES WASHER	AUTOMATIC DISH WASHER	WATER SOFTENER	OCCUPATION OF HEAD OF HOUSEHOLD
A	2	2 (8,18)	2 1/2	YES	YES	YES	HERDSMAN
B	2	1 (15)	1 1/2	NO	YES	NO	EARTH CONTRACTOR
C	2	2 (3,5)	1	YES	NO	YES	HERDSMAN
D	2	4 (10,12,17,19)	2	YES	YES	YES	RESORT EMPLOYEE
E	2	1 (9 mo.)	2	YES	YES	NO	PHARMACIST
F	2	3 (6,8,9)	1 1/2	YES	NO	NO	PAPER MILL WORKER
G	2	5 (4,9,15,17,18)	1 1/2	YES	NO	YES	DAIRY FARMER
H	3	0	1	YES	NO	YES	FARM WORKER
I	2	3 (2,3,5)	1 1/2	YES	YES	NO	MEAT CUTTER
J	2	5 (3,7,11,16,17)	1 1/2	YES	NO	NO	AGRONOMIST
K	2	2 (8,15)	2	YES	NO	YES	AGRICULTURE PROFESSOR

without the participants knowing. This of course was not possible. Elimination of bias was given major consideration when the equipment available for purchase was being examined.

RESULTS AND DISCUSSION

A. Individual Homes

When the information was collected and analyzed, it was apparent that each home was different in family life style and water use habits. With the tabulation of the flow characteristics, two graphs were developed for each home. The first presented the flow characteristics for each hour of the day.

The volume for each use was represented by the corresponding area on the graph with the upper edge of the plot giving the total use in gallons per capita per hour for the 24 hours of the day.

A second plot was constructed to illustrate the trends of water usage for each event during the days of the week and the total average water usage for each day of the week. By integrating the area under the curve the total water used per day can be found. These two graphs are presented for each family in the following section of this report.

A chart recorder, driven by the water meter in the home, was chosen for the purposes of making a record of the water use vs. time. Charts were changed on a weekly basis thus eliminating much of the homeowner's involvement to lessen the chance of this study influencing the normal day-to-day life style of the family. To aid in the verification of the data, counters were installed on the toilets and any large extraordinary flows were checked by talking with the homeowner.

From the charts, events were identified and the corresponding volume for each event was measured. This information was tabulated by each hour of the day and by each day of the week.

When the data was tabulated, two computer programs were developed to analyze the data and to provide a clear and consistent presentation of the results.

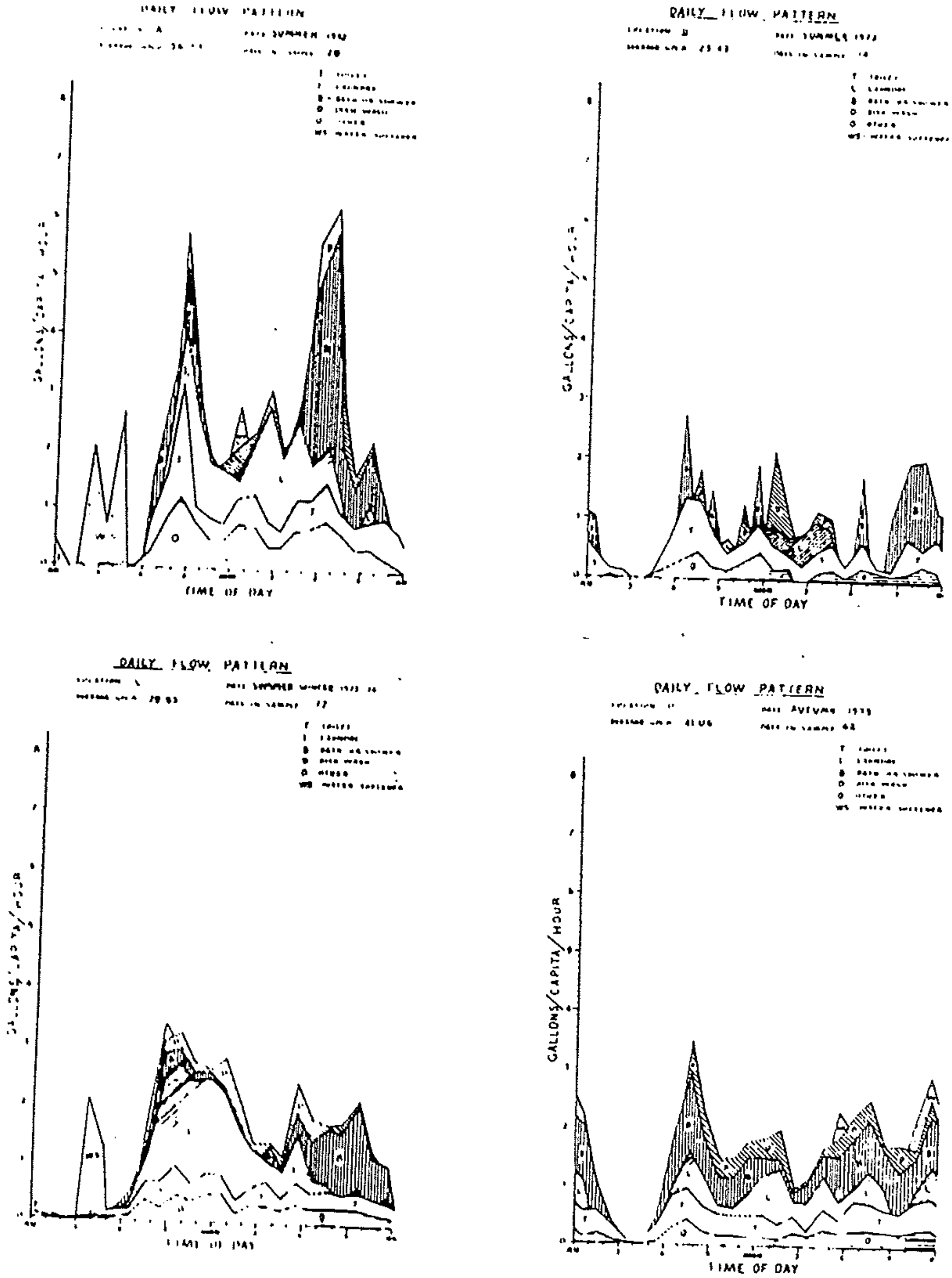

DAILY FLOW PATTERN
TIME OF DAY
DAILY FLOW PATTERN
TIME OF DAY
DAILY FLOW PATTERN
DAILY FLOW PATTERN
GALLONS/CAPITA/HOUR
TIME OF DAY

Figure 2

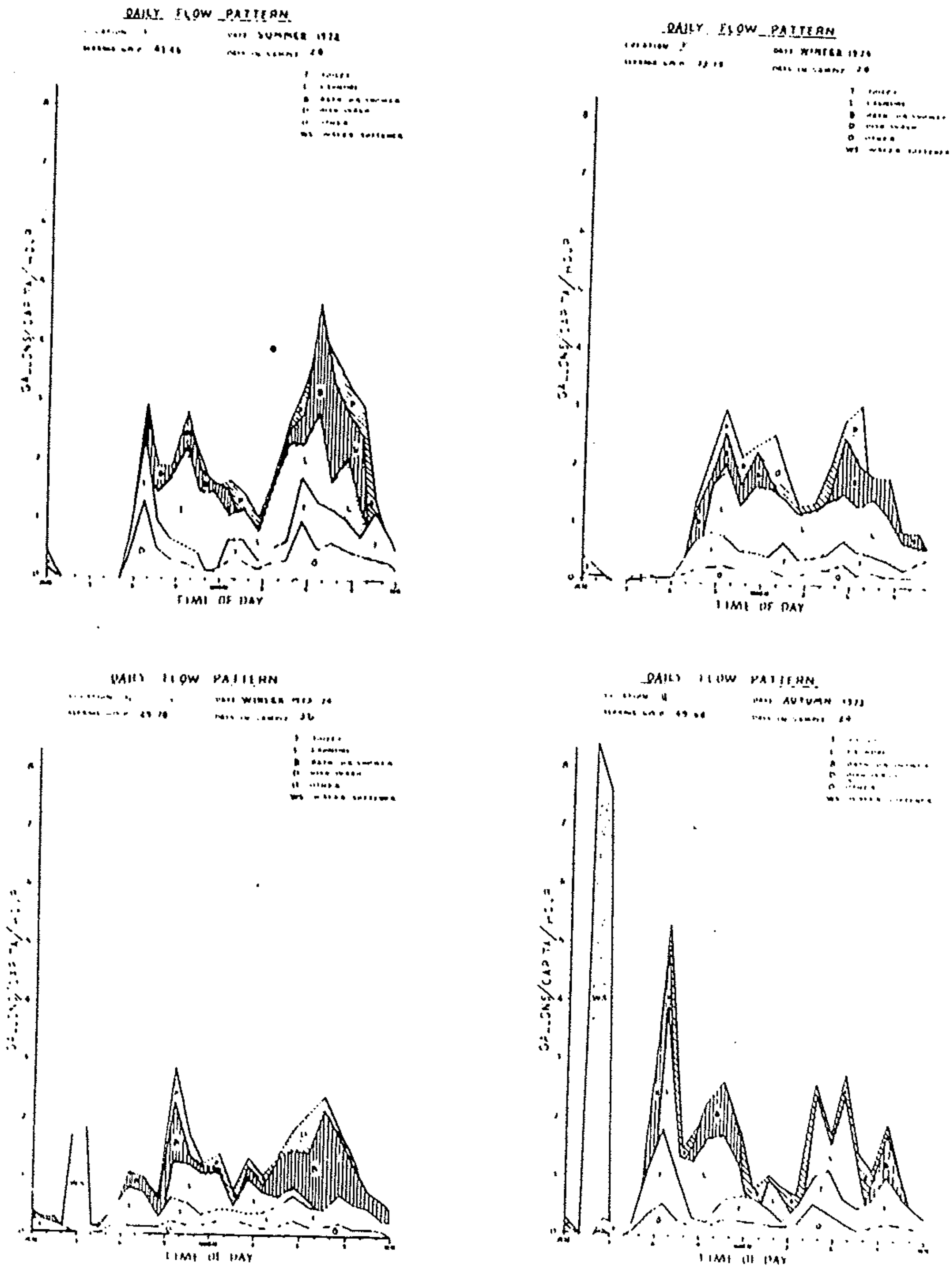


Figure 2 (Cont'd)

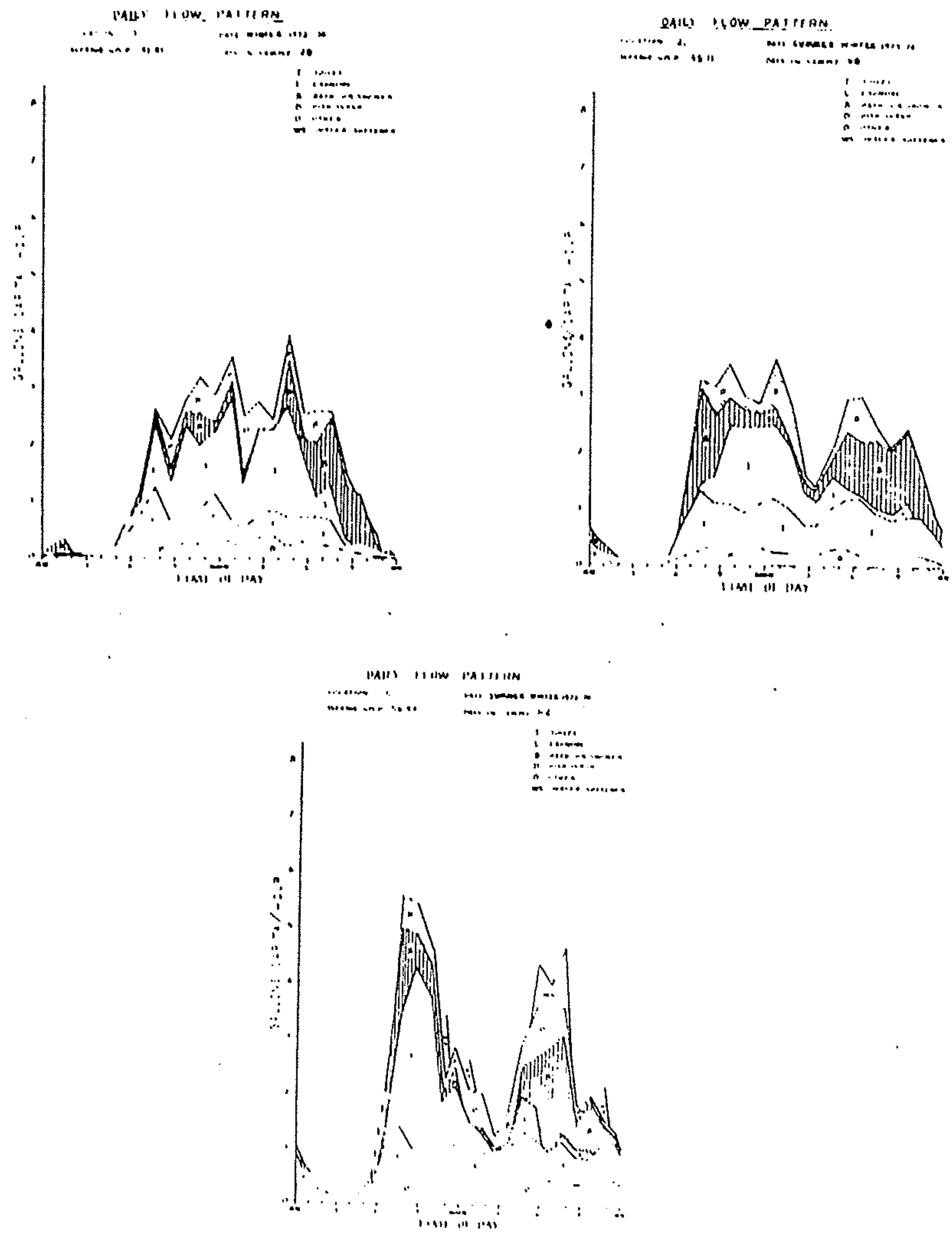


Figure 2 (Cont'd)

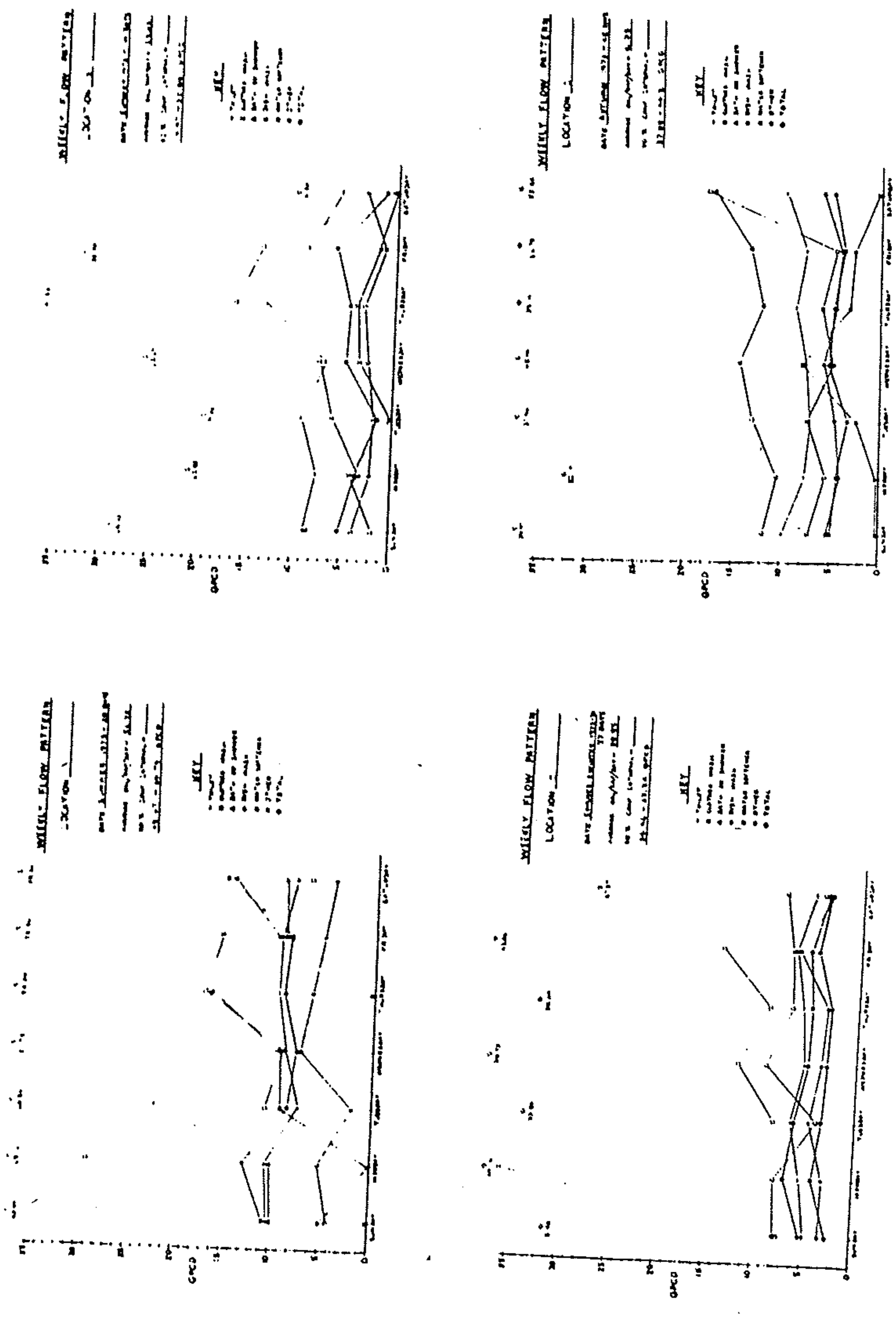
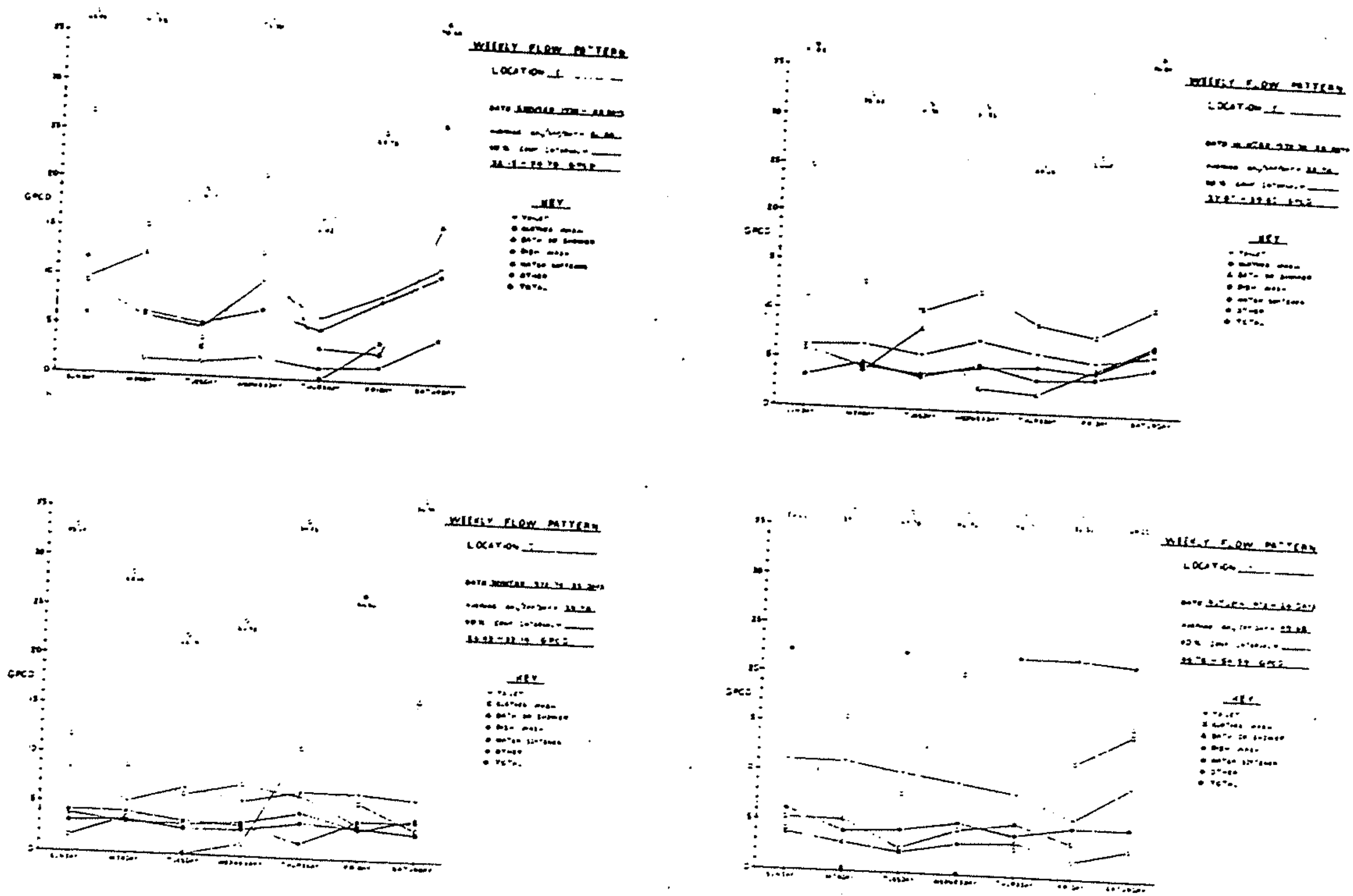


Figure 3



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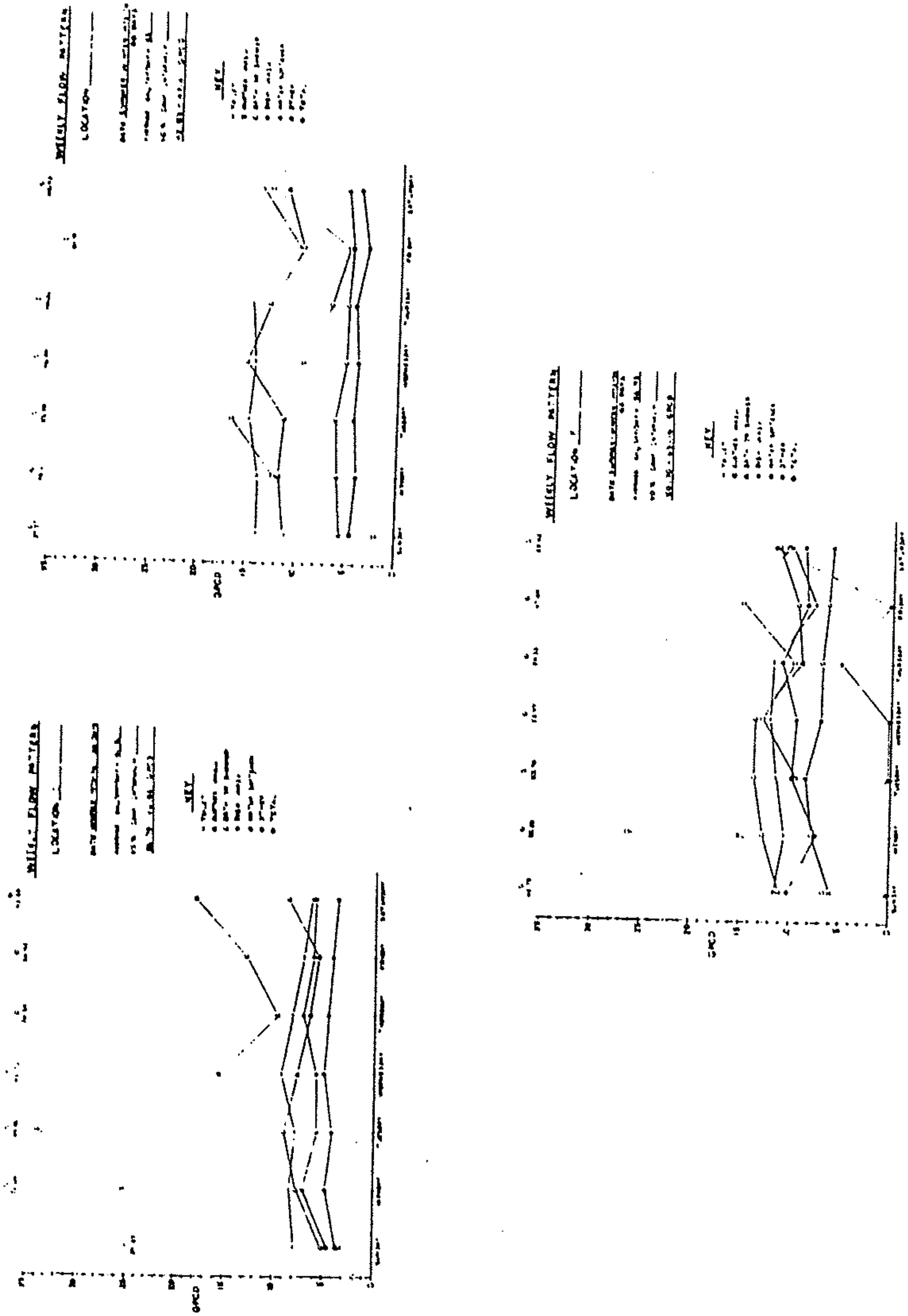

Figure 3 (Cont'd)

B. Summary of Homes

In addition to individual analyses, information from all homes was analyzed as a single sample. An average flow of 42.59 gpcd was calculated for all data with a 90% confidence interval of 40.84-44.35 gpcd for the 434 sampling days. The average values calculated were weighted by the number of days each home was sampled. The confidence intervals for the eleven homes and the averages are presented in Figure 4 to make visual comparison easier. Table 2 presents a summary of the number per capita per day for each event and the corresponding average size of each event for the eleven homes. Table 3 tabulates the volume of flow used by each event in the homes sampled. This information was then plotted in Figures 5 and 6 to show the variations from day-to-day and by hour of the day.

Little variation in the flow existed for any of the events except the bath and laundry. The bath showed a significant difference at the 90% confidence interval between Friday at 8.04 gpcd and Saturday at 12.11 gpcd. The laundry demonstrated

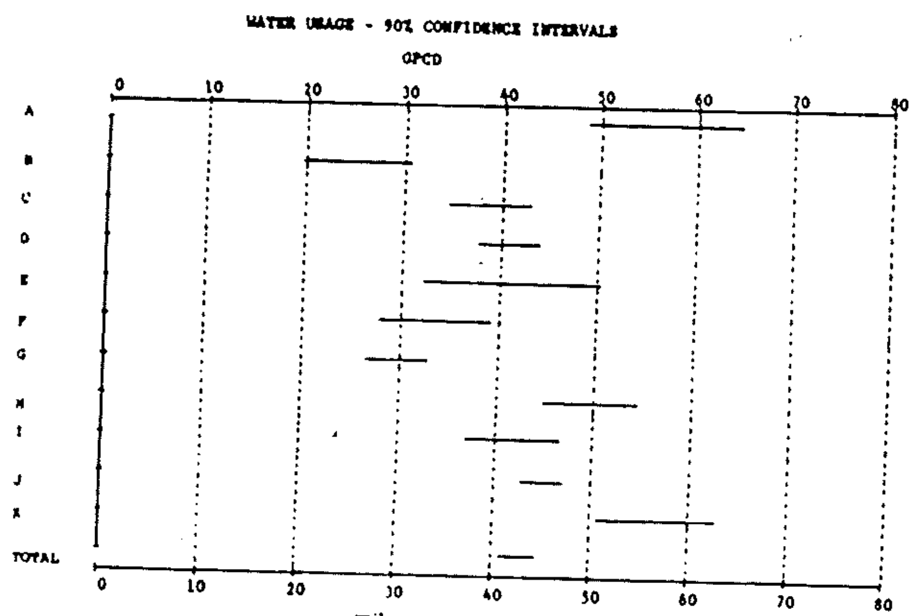

Figure 4

Table 2

FREQUENCY AND SIZE OF EVENTS

LOCATION	TOILET		LAUNDRY		BATH OR SHOWER		DISH WASH		WATER SOFTENER	
	FREQ. NO/CAP/DAY	AVERAGE SIZE GALLONS	FREQ. NO/CAP/DAY	AVERAGE SIZE GALLONS	FREQ. NO/CAP/DAY	AVERAGE SIZE GALLONS	FREQ. NO/CAP/DAY	AVERAGE SIZE GALLONS	FREQ. NO/CAP/DAY	AVERAGE SIZE GALLONS
A	2.07	4.40	0.36	35.42	0.43	31.54	0.29	17.00	0.08	75.67
B	2.29	3.80	0.19	11.37	0.38	20.87	0.26	10.18	-	-
C	1.70	3.31	0.36	36.32	0.31	23.61	0.31	11.16	0.06	71.65
D	2.79	3.00	0.23	33.17	0.66	20.13	0.41	12.17	0.02	95.17
E	1.71	4.80	0.33	41.86	0.45	19.03	0.24	11.60	-	-
F	1.39	4.51	0.46	27.28	0.26	22.28	0.39	12.78	-	-
G	1.49	4.34	0.15	28.61	0.47	18.48	0.36	10.48	0.05	69.83
H	2.29	4.00	0.32	34.91	0.36	16.27	0.36	7.92	0.24	66.41
I	1.68	4.72	0.59	27.68	0.34	21.28	0.49	12.46	-	-
J	3.10	4.44	0.27	34.92	0.57	21.51	0.40	13.75	-	-
K	2.93	3.73	0.34	38.37	0.55	21.23	0.54	13.27	0.03	144.62
AVERAGE (Weighted)	2.29	3.99	0.31	33.49	0.47	21.35	0.39	12.50	0.03	81.07

Table 3

WATER USAGE--GPCD

LOCATION	TOILET	LAUNDRY	BATH OR SHOWER	DISH WASH	WATER SOFTENER	OTHER	TOTAL	90% CONFIDENCE INTERVAL	DAYS
A	9.10	12.63	13.50	5.00	6.07	10.42	56.73	48.67-64.79	28
B	8.69	2.17	7.95	2.67	0.0	3.95	25.43	19.97-30.88	14
C	5.63	13.08	7.28	3.48	3.95	5.43	38.85	34.46-43.24	77
D	8.37	7.63	13.26	4.98	2.27	4.54	41.05	37.88-44.21	42
E	8.23	13.95	8.61	2.76	0.0	7.92	41.46	32.15-50.78	28
F	6.24	12.66	5.73	5.02	0.0	4.08	33.74	27.87-39.60	28
G	6.49	4.20	8.67	3.72	3.42	3.27	29.78	26.43-33.14	35
H	9.17	11.15	5.88	2.86	15.68	4.94	49.68	44.78-54.59	24
I	7.92	16.21	7.14	6.14	0.0	4.39	41.81	36.79-46.82	28
J	13.75	9.54	12.16	5.52	0.0	4.16	45.11	42.82-47.41	68
K	10.91	13.00	11.73	7.12	4.67	9.51	56.93	50.70-63.16	62
AVERAGE (Weighted)	9.16	10.51	10.00	4.86	2.64	5.43	42.59	40.84-44.35	434

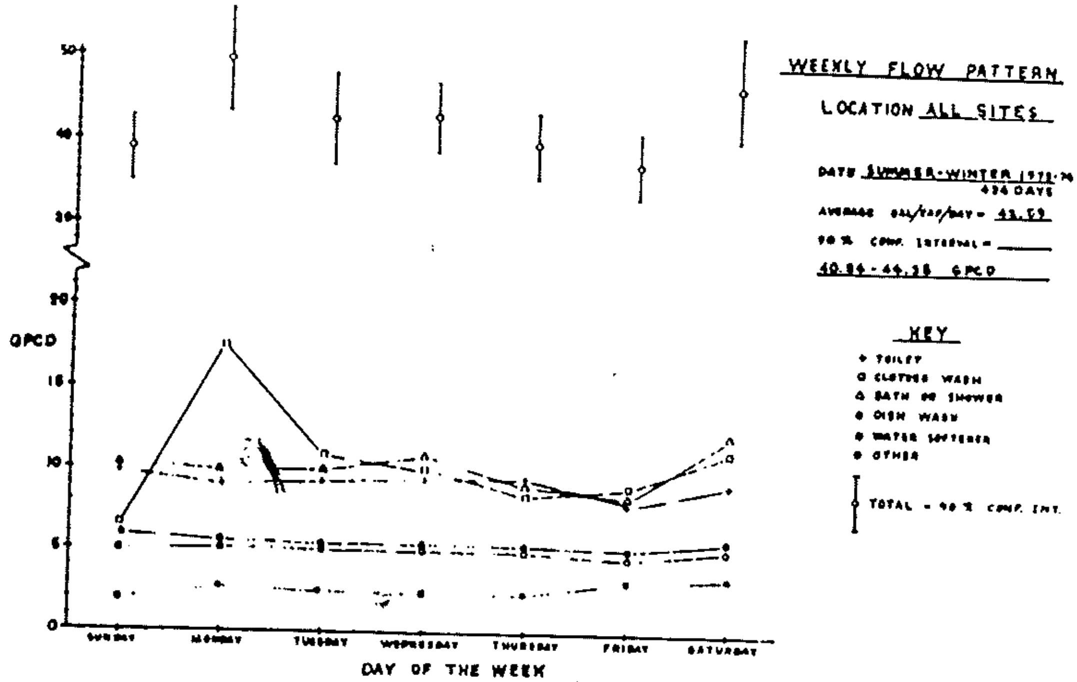

Figure 5

a significantly higher contribution on Monday, when compared to all days except Tuesday, at the 90% level of confidence. Figure 5 illustrates a significant difference when comparing Monday to either Sunday or Friday. When considering total flow for all days, however, no one day was significantly different from the average.

The hourly pattern again shows two major times of high usage in the morning and evening hours with lower demands during late night, early morning and afternoon periods of the day. The miscellaneous or other flow is quite constant from 6 a.m. to midnight with lower flow during the early morning hours. Toilet flushings followed a similar pattern with a slight increase between 6 and 8 a.m. Laundry was largely concentrated in the morning with 63% of it occurring

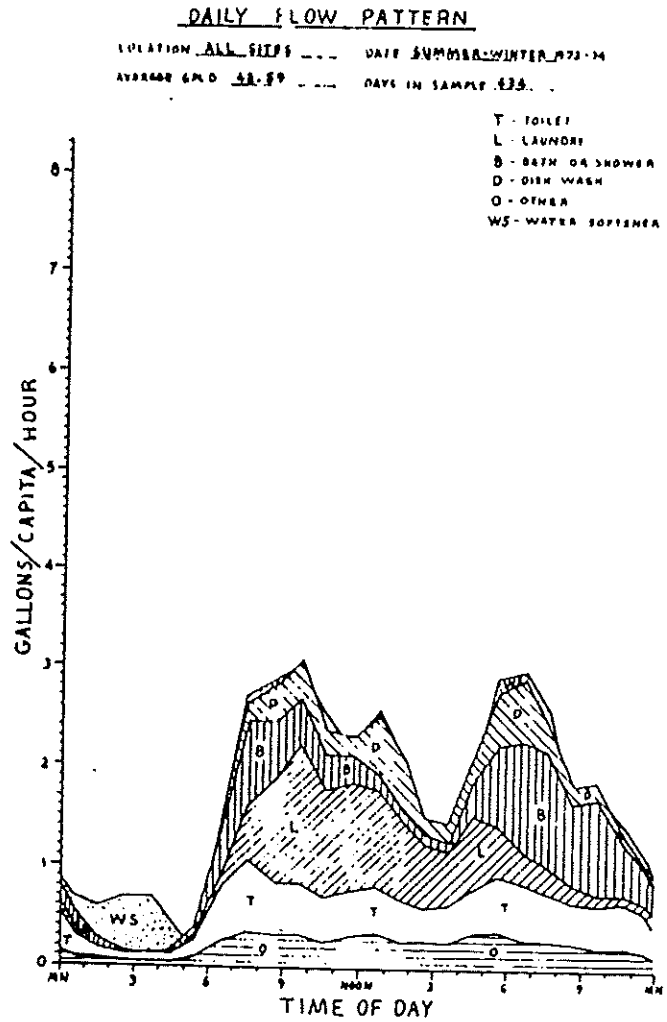

Figure 6

between 7 a.m. and 2 p.m. Baths and showers were most often found in the evening hours between 5 p.m. and midnight although the morning hours of 6 to 9 a.m. also showed an increase from this event. Dishwashings were measured in three peaks following the mealtimes with the largest flow between 5 and 7 p.m. As would be expected the water softener was concentrated between midnight and 5 a.m. when the other five events were at a minimum.

The results of this study were comparable to similar values reported in the last 12 years as shown in Table 4.

Table 4

WATER USAGE COMPARISON--PERCENTAGE

	USGS[8] 1962	HANEY & HAMANN[5] 1967	LAAK[6] 1971	LIGMAN[7] 1972	WALLMAN[9] 1972	ONTARIO RESEARCH[3] 1973	BENNETT[2] 1973	THIS STUDY 1974
TOILET	41	45	43	41	27-45	38	33	22
LAUNDRY	4	5	16	19	18	12	26	25
BATH	37	30	19	26	18-36	34	20	23
KITCHEN	6	6	8	10	13	10	12	11
CLEANING	3	4	5	1	-	3	3	-
DRINKING	5	3	3	3	-	3	3	-
MISC.	4	7	6	0	6	0	3	13 OTHER 6 WATER SOFTENER
FLOW (gpcd)	-	-	41	45	30-50	-	44	43

Due to the ever increasing number of modern appliances that have been introduced in the last 20 years, the uses of water within the home has changed greatly. Trends have developed which indicate greater usages in the kitchen and laundry relative to total usage. This can be explained by the introduction of automatic dishwashers, garbage disposals, and clothes washers which use more water for the permanent press fabrics. Changes in the habits of people may have also affected the volume of water and the way it is used in the home.

C. <u>Winter vs. Summer</u>

Three homes (C, J, K) were chosen for investigation of the changes in flow patterns and water usage which might exist between the summer and winter seasons. It was believed that with the children in school in the winter, a significant difference in some events might be measured. Table 5 presents a summary of the water usage for these 3 sites as measured during the winter and summer seasons.

Home C demonstrated a significantly lower average flow during the winter of 31.61 gpcd as compared with 44.88 gpcd in the summer. Slight decreases in water usage were evident in all events measured. An especially large decrease was found in the water softener of 4.15 gpcd. This was because the frequency of the regeneration cycle was decreased in an

Table 5

SUMMER-WINTER WATER USAGE

LOCATION	TOILET		LAUNDRY		BATH		DISHES		W. SOFT.		OTHER		TOTAL	90% CONFIDENCE INTERVAL	DAYS
	NO/CAP/DAY	GPCD	NO/CAP/DAY	GPCD	NO/CAP/DAY	GPCD	NO/CAP/DAY	GPCD	NO/CAP/DAY	GPCD	NO/CAP/DAY	GPCD	GPCD	GPCD	
C SUMMER	1.84	6.12	0.38	14.12	0.33	8.47	0.37	4.04	0.08	5.84	-	6.29	44.88	38.50-51.27	42
C WINTER	1.53	5.04	0.34	11.84	0.29	5.84	0.24	2.79	0.02	1.69	-	4.41	31.61	26.31-36.91	35
J SUMMER	3.42	15.01	0.26	9.19	0.55	11.85	0.39	5.43	0.0	0.0	-	3.62	45.09	41.94-48.24	42
J WINTER	2.58	11.71	0.29	10.09	0.59	12.65	0.41	5.66	0.0	0.0	-	5.03	45.15	41.90-48.40	26
K SUMMER	2.53	9.26	0.34	13.04	0.52	10.37	0.48	6.83	0.03	2.89	-	7.48	49.86	43.68-56.04	35
K WINTER	3.44	13.06	0.33	12.94	0.59	13.48	0.61	7.49	0.04	6.97	-	12.15	66.09	54.74-77.45	27

effort to reduce the amount of salt being used. This change was not due to a change in the season of the year. If this drop had not occurred there would have been no significant difference between the winter and summer flows.

Home J displayed no significant difference in total average flow although changes were found in the contributions from each event. The toilet frequency decreased during the winter and could be attributed to the 5 children who were all away from home during the weekdays. The effect of this decrease was offset by slight increases in all other events, the largest being the miscellaneous flow with an increase of 1.41 gpcd.

At home K the average flow increased by 16.23 gpcd although this was not significant at the 90% level of confidence. The largest increases were noted in the toilet, bath, water softener, and other flows. Interesting to note is the increase in the average size during the winter of the bath from 19.89 to 22.75 gallons and the water softener from 101 to 188 gallons per cycle. Wide variations existed in the size of the water softener cycle because it was operated manually. Often the water was turned on for 2-3 hours when regenerating without being checked, thus resulting in excessive flows. The largest per capita increase was evident in the miscellaenous (other) flow with an increase of 4.67 gpcd. This was caused by two sources within the home: (1) leaking faucets during the sampling period and (2) use of a humidifier attachment on the furnace.

The information from these three sites indicates that individual households demonstrate widely varying characteristics which are more important in determining the water usage than is the season of the year.

POSSIBLE WATER USE REDUCTIONS

The volume of water and the way in which it is used varies greatly from home to home. In nearly all instances however, the usage of water is somewhat wasteful. Thus a savings in water might be accomplished by change in usage habits or by simple mechanical changes in the appliances or plumbing systems. As reported by General Daynamics[1] in their study of flow reduction and as supported by this study, the major areas of water usage are the toilet, laundry, and bath. These three events accounted for almost 70% of the total water used in this study. It seems reasonable, then, that the most substantial water savings might be made in these areas.

To look at the possible savings which might be accomplished in these homes, four water saving methods, including one recycling scheme were hypothetically applied to each home studied. Each was used to estimate the potential water savings which might exist.

The toilet is probably the most wasteful appliance in the home. It usually uses between 4 and 6 gallons of water to transport a very small amount of waste material from the home. By reducing the size of each flush to 3 gallons, a substantial savings can usually be made. In some cases this can be accomplished by using toilet inserts such as water filled glass jars and adjustment of the float setting. In other cases, a change in the type of toilet being used would be necessary. Recently, shallow trap toilets have been made commercially available in the United States by manufacturers. These units have a redesigned bowl which requires less water for scouring and use from 3.0-3.5 gallons per flush. In Great Britain the use of dual flush toilets has become mandatory in some areas. These deliver 1 1/4 or 2 1/2 gallons per flush. Many other innovations such as the incinerator toilet using little or no flow are available, but usually are not as acceptable to the homeowner.

A second possible savings can be made in the laundry by using a "sudsaver." This is no more than a large sink or tank which holds the wash water from one cycle after which it is reused for washing the next load of clothes. A sudsaver was used by three sites in the study (F, G, I) and resulted in an average size clothes wash of 27.86 gallons per load compared to 35.00 gallons for the other homes using automatic clothes washers. An average from these three homes was applied to the others to estimate the possible reduction in water usage.

A third method of reducing water use is to limit the amount of water used for baths and showers to 15 gallons.

Showers are especially wasteful when persons extent the length beyond 5 minutes. A flow of 3 gpm for 5 minutes should be adequate in most cases. A 15 gallon bath is equivalent to a depth of approximately 4 inches in a normal tub for a bath. This seems adequate for personal bathing requirements, especially since many baths of a smaller volume than this were observed in this study.

Table 6 shows the calculations made to estimate the average water savings which would be possible in this study. Note that the number of events per capita per day (see Table 2) is not changed. The average size is that found for each event in this study. From these the normal usage is computed and then the usages are computed with each of the three changes and with all three used simultaneously, resulting in a reduction of 17% with all three applied.

The fourth method of achieving flow reduction in the home is to reuse or recycle water. One of the simplest ways to do this is to provide a collecting tank to save the bath, shower, and laundry water to be used for flushing the toilet. Figure 7 shows a sketch of this type of system. If enough water is available from these sources, the use of fresh water for the toilet could be eliminated completely. This has been calculated in the last column of Table 6. Note that this includes the effects of the first three water saving reductions plus the recycling to the toilet. With this type of system a savings of 33% results.

Table 6

POSSIBLE WATER REDUCTIONS
USING AVERAGE VALUES FOUND
ALL VOLUMES IN GPCD

Event	No/Cap/Day	Average Size of Event	As Measured	With 3 Gal./ Flush	With Sudsaver @ 27.86	With 15 Gal. Bath/ Shower	With All Three Used	Recycle Bath/Laun. to Toilet
TOILET	2.29	3.99	9.16	6.87	9.16	9.16	6.87	0
LAUNDRY	.31	33.49	10.51	10.51	8.64	10.51	8.64	8.64
BATH	.47	21.35	10.00	10.00	10.00	7.05	7.05	7.05
DISHES	.39	12.50	4.86	4.86	4.86	4.86	4.86	4.86
W. SOFT	.03	81.07	2.64	2.64	2.64	2.64	2.64	2.64
OTHER	-	-	5.43	5.43	5.43	5.43	5.43	5.43
TOTAL	-	-	42.60	40.31	40.73	39.65	35.49	28.62

RECYCLE OF BATH AND LAUNDRY
WATER TO TOILET

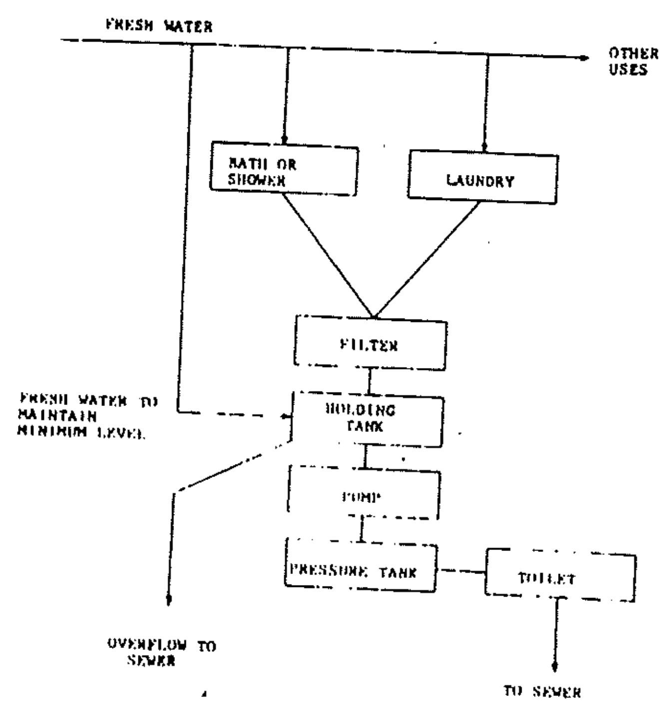

Figure 7

Table 7

POSSIBLE WATER REDUCTIONS
ALL VOLUMES IN GPCD

LOCATION	Average GPCD	With 3 Gal./Flush	With Sudsaver @27.86 Gal	With 15 Gal. Per Bath or Shower	With All Three Methods Used	% Reduc. Accomp. With Three	With Addition of Recyc. Bath/Laun. to Toilet	Total % Reduction Using All Four Methods
A	56.73	53.84	54.13	49.68	44.18	22%	37.97	33%
B	25.43	23.61	25.43	23.18	21.36	16%	14.49	43%
C	38.85	38.32	35.80	36.22	32.64	16%	27.54	29%
D	41.05	41.05	39.83	37.69	36.47	11%	28.10	32%
E	41.46	38.36	36.70	39.60	31.75	23%	26.62	36%
F	33.74	31.67	33.74	31.91	29.83	12%	25.66	24%
G	29.78	27.76	29.78	28.16	27.75	7%	23.28	22%
H	49.68	47.38	47.45	49.20	44.67	10%	37.80	24%
I	41.81	38.93	41.81	39.77	36.88	12%	31.84	24%
J	45.11	40.67	43.09	41.35	34.90	23%	25.60	43%
K	56.93	54.81	53.40	53.45	47.81	16%	39.02	31%
AVERAGE (Weighted)	42.59	40.31	40.73	39.65	35.49	17%	28.62	33%

In Table 7 the estimated effects of these four methods are summarized for each of the eleven homes in this study. It is interesting to note that significant savings can result in most homes without the recycle system. At all sites, however, with the installation of the recycle system having a holding tank of adequate size, no fresh water would be needed for the toilet. This then results in total savings ranging from 22-43%.

The potential water savings at these sites are comparable with those found by General Dynamics[4] and the Washington Suburban Sanitary Commission (WSSC)[10] Although the exact method of water saving was somewhat different in the bath and shower, comparisons can still be made. Those savings found by General Dynamics were the result of a demonstration project using the devices named. The WSSC findings are somewhat high since an education program designed to inform participants of ways to develop better water use habits was initiated simultaneously with the installation of the devices. The comparisons are shown in Table 8.

In addition to the savings which might be accomplished by using these devices, additional steps could be taken which would result in a further flow reduction. These include such devices as aerators on all faucets, pressure regulators using smaller amounts of water.

A second major area of potential water savings is in the education of the user. Little work has been done in this area. One exception is the WSSC which ran extensive tests during 1972 covering 2,400 homes and 4,800 flow reducing devices.

Table 8

WATER SAVINGS COMPARISON--PERCENTAGE

Method	General Dynamics[4]	WSSC[10]	This Study**
Shallow Trap Toilet or Toilet Device	6.9	10*,**	5.5
Flow Limiting Shower Head	1.0	12*	-
15 Gallon Bath or Shower	-	-	6.9
Clothes Washer "Sudsaver"	2.0**	-	4.4
Recycle System (Bath and Laundry to Toilet)	27.0	-	21.5

*May be higher due to education program.

**Estimated from study, not demonstrated.

These devices consisted of pressure reducing valves, toilet inserts, and reduced flow shower heads. The toilet insert was a water-filled weighted plastic bottle rather than a brick. A booklet containing many suggestions for water conservation was distributed to the participants. The results of the study were quite encouraging. In homes where toilet inserts were used in conjunction with pressure reduction (to 50 psi), water use was reduced by more than 30%. Flow reducing shower heads were credited with a 12% reduction in water use. How much of this reduction was due to flow reducing devices and how much was due to education was not presented. Because of the success of this project, requirements of the plumbing code for the WSSC were changed in 1972 to promote continued water saving. Newly installed toilets were required to provide a maximum flush of 3 1/2 gallons. Shower heads must deliver a maximum flow of 3 1/2 gpm or less. Aerators were required on all kitchen sinks and lavatories to result in a flow of approximately 3 gpm, and pressure reducing devices were required on all connections where water pressure was expected to exceed 60 psi.

CONCLUSIONS

1. The water usage in eleven homes was monitored for a total of 434 days yielding an average flow of 42.59 gpcd with a 90% confidence interval of 40.84-44.35 gpcd. (See Table 3)
2. Monday was found to have the highest flow with 49.73 gpcd while Friday had the lowest with an average of 37.51 gpcd. (See Figure 5)
3. Of the 42.59 gpcd measured, laundry made up the largest percentage with 24.67% while baths and showers were 23.48%, toilet flushings were 21.50%; dishes 11.41%; water softeners 6.20%; and other flow 12.74%.
4. The average size of the events in these households was found to be: (1) toilet 3.99 gallons, (2) clothes washing 33.49 gallons, (3) bath and shower 21.35 gallons, (4) dishwashings 12.50 gallons, and (5) water softener 81.07 gallons. (See Table 2)
5. By reducing all toilet flushes to an average of 3.00 gallons, all clothes washings to an average of 27.86 gallons by using a sudsaver, and all baths and showers to 15 gallons, a possible reduction in water use of 7% to 23% with an average of 17% was estimated for the homes studied. With the addition of a recycling system using bath and laundry water to flush toilets, the estimated savings was 22-43% with an average of 33%. (See Table 7)

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