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RESIDENTIAL GREYWATER MANAGEMENT

RESIDENTIAL GREYWATER MANAGEMENT IN CALIFORNIA

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FOREWORD

New concepts of greywater management for rural residences or small communities are discussed in this report.

The California drought of 1976–77 was responsible for an increased awareness of the benefits of greywater use.

Inadequate information on the public health impacts of greywater use concern health officials. Therefore effective greywater use dictates continuing work in the area of public health and water quality.

Greywater use should be practiced within the framework of a management program incorporating some details not met in a typical on-site septic tank management plan.

Greywater management requires that an informed user voluntarily work with the local agency.

The program is based on the concepts of use authorized by a permit. All system maintenance and repair is the responsibility of the permittee. The local agency is responsible for inspection, monitoring and enforcement. Abuse of the application of greywater could result in loss of the permit.

Without a permit, all wastewater would be directed to subsurface disposal.

The findings reported herein are those of the author and do not necessarily reflect the opinion or policies of the State Water Resources Control Board.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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RESIDENTIAL GREYWATER MANAGEMENT

I. INTRODUCTION

The use of greywater is a method of water conservation. It has implications for wastewater treatment and disposal, but its main purpose is a more complete use of the water supply. This discussion is restricted to the use of greywater in the individual California residence. The general on-site use of greywater in California is a new concept, originating primarily with the drought of 1976-1977. Widespread greywater use in several parts of California during the 1976-1977 drought underscored the need for a comprehensive review of individual household recycling practices. Prior to 1976, greywater usage was not allowed in any counties of the State. It still is prohibited in many areas. It is the intent of this report to present a general discussion of greywater usage and suggest a framework for the establishment of regulatory procedures for residential greywater management. This report is intended to provide information to the home-owners, local regulatory agencies, and persons in state government or the private sector interested in greywater use.

To provide some background and perspective on the subject of greywater use, this section discusses historical water use patterns, increasing population density and adequacy of present water supplies. A definition of greywater is given and a discussion is made of the water uses in the home.

A. Historical Water Use Patterns

A supply of potable water has been essential to mankind since his appearance on earth. The first supplies of water were taken from nearby surface water. This largely dictated the geographic settlement of man.

Groups of people settled together near rivers and streams. The water was used exclusively for direct consumption. The water demand was extremely small. As tribes grew, surface supplies were inconvenient and wells were dug. The Romans built the first large aqueduct system to bring water to Rome. Water was used for artistic fountains, baths, street washing and sewers to transport sewage. A bountiful supply of water was recognized as essential to a civilized lifestyle.

The discharge of sewage-bearing waters to surface streams created pollution problems which were realized during the Middle Ages and remain of concern today.

Per capita water consumption continued to increase to the present day where the national total residential water consumption is 89 gallons per capita per day (gpcd) and ranges from 20 to 600 gpcd (1). Water use

in today's home is not restricted to bathing, cooking and toilets, but includes increasing quantities for

fail because of increased system use due to added persons and new water-using appliances. In many cases when a new leachfield is properly designed to replace a failing undersized system, it is found that there is inadequate lot area available. This problem can be solved by (1) acquiring more land, (2) going to a more costly on-site disposal system, (3) a collection system (also very costly), (4) the implementation of water conservation practices or a combination of these alternatives.

Water conservation methods can be the least expensive solution to a wastewater disposal problem, and they benefit the general community by lowering the per capita water consumption, thus lowering the demand on

TABLE 1

WATER USAGE IN CALIFORNIA[1/]

Gallons/Capita/Day

Hydrologic Study Area	Urban[2/]	Residential[3/]	Interior[4/]	Exterior[5/]
North Coastal	521	354	198	156
San Francisco Bay	179	122	68	54
Central Coastal	194	132	73	58
South Coastal	179	122	68	54
Sacramento Basin	351	239	133	105
Delta-Central Sierra	315	214	120	94
San Joaquin Basin	436	296	165	130
Tulare Basin	363	247	138	109
North Lahontan	492*	334*	187*	147*
South Lahontan	305	207	116	91
Colorado Desert	378	257	144	113
Mean	338	229	128	101

* Includes recreational usage

1/ Source Ref.: 2

2/ Usage (1966-1970)

3/ Residential average for State is 68% of Urban (1972)

4/ Interior water usage average for State is 56% of Residential total (1972)

5/ Exterior water usage average for State is 44% of Residential total (1972)

In much of the United States, exterior water use is seasonal. In parts of California, however, lawns and gardens may be watered throughout the year.

Ninety percent of the exterior residential water use in California is for landscape irrigation; the remaining ten percent is for washing cars, sidewalks, drives,

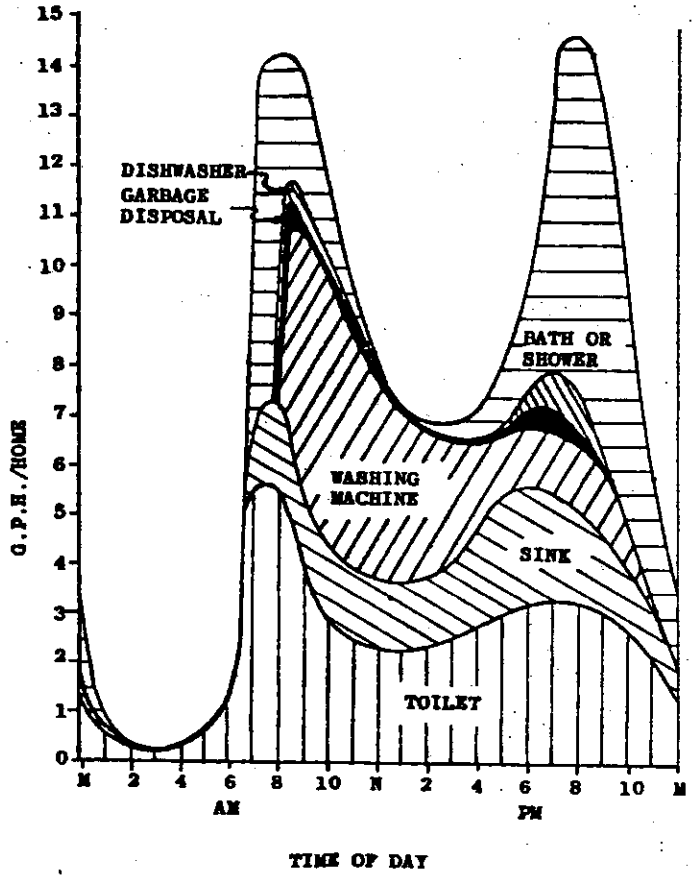

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Figure 1. Daily Household Water Use

TABLE 2

RESIDENTIAL INTERIOR PER CAPITA WATER
CONSUMPTION IN CALIFORNIA AND THE NATION

	Gallons/Capita/Day		Percent of Total Use	
	California[1/]	National[2/]	California[1/]	National[2/]
Toilet flushing	54	25	42	39
Bathing and hygiene	41	22	32	34
Laundry	18	9	14	14
Dish Washing	)	4	)	6
Drinking and Cooking	15)	3	12)	5
Miscellaneous Cleaning	)	1	)	2
TOTALS	128	64	100	100

1/ Source Ref.: 2 and Table: 1

2/ Source Ref.: 1

II. CONSIDERATIONS FOR GREYWATER USE

The application of greywater for uses in and about the home presents many important aspects to be considered. The most important considerations center around health concerns and public acceptability. The treatment given greywater technically is determined by the intended use. However, little work has been done to establish treatment standards for greywater use. Regulations must be developed; yet the development of regulations must be based on additional technical information and, most importantly, public policies must be receptive to greywater implementation if technically feasible. Technical feasibility must be proven. An ongoing testing and certification program is one way to verify technically feasible systems. The final step in greywater use is an education program to make the user aware of his responsibilities for the effective, safe use of greywater.

A. Health Aspects of Greywater

A prime consideration when planning treatment, disposal or use of any residential wastewater is the potential presence of infectious agents. The following factors should be considered (6):

1. The agent, infectious or toxic;
2. Character of wastewater and the concentration (dose) of disease agents;
3. The host response to the disease agents; and,
4. The manner in which the host encounters the agent.

1. Agents of Disease

Diseases associated with animals and man can originate from the mismanagement of wastewater. Surfacing of wastewater can promote the breeding of flies or mosquitoes. Wastewater and garbage disposal can attract rodents and other vectors of disease. Many bacterial, viral or parasitical agents are associated with feces. Fecal contamination can be present in greywater, especially when the greywater is from laundry facilities washing diapers.

Wastewater, even residential wastewater, can contain noninfectious toxic agents such as pesticides, solvents, etc. These could be present in greywater if such compounds are placed down drains feeding greywater systems such as laundry trays.

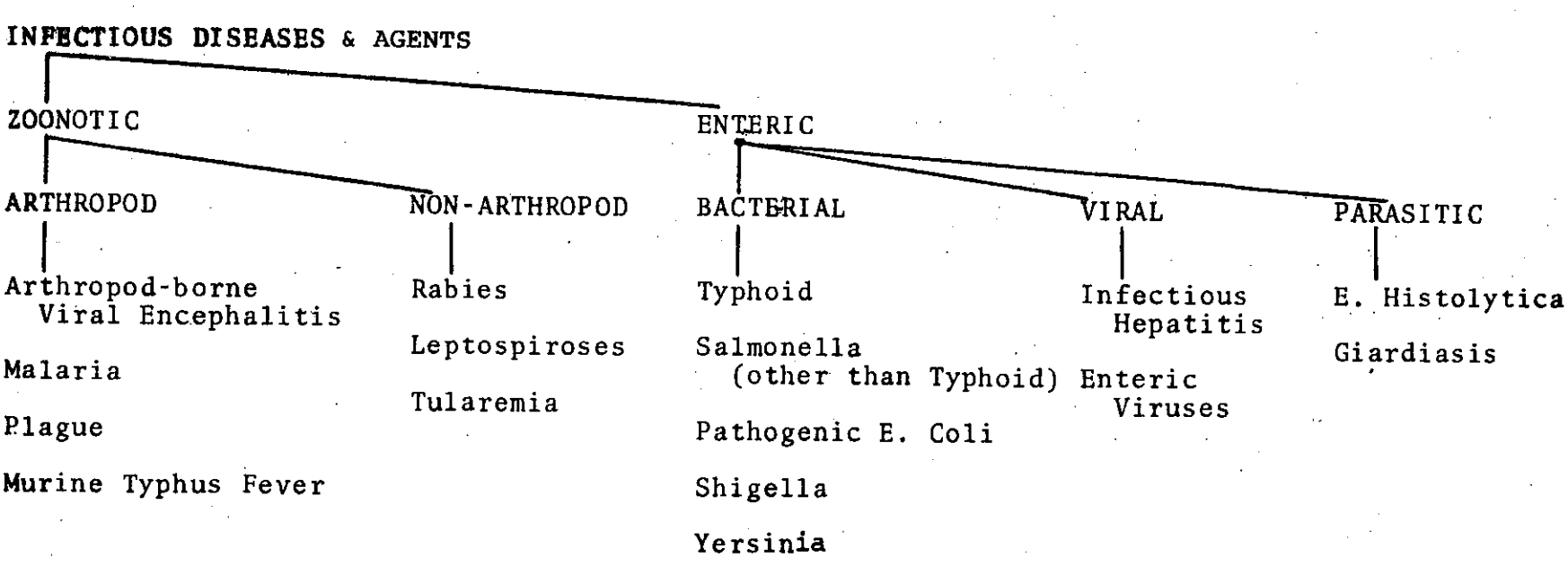
Aesthetics is a very important consideration of wastewater management. The treatment or use of greywater should not impair the quality of life due to the presence of nuisance insects or odors, even though their presence does not necessarily transmit disease.

The public health problems discussed above are diagramed in Figure 2.

2. Characterization of Wastewater and the Dose of Disease Agents

The content of wastewater and dosage of disease agents is the second primary concern when discussing public health and wastewater. The larger the number of disease agents, the greater the chance of illness. The relative disease agent concentrations and survival rates are important when considering treatment systems for wastewater. Concentrations and survival rates of disease agents in greywater are not well known. Preliminary work indicates a substantially lower concentration of disease agents in greywater than in black or combined waters (3).

Little is known about the bacteriological content



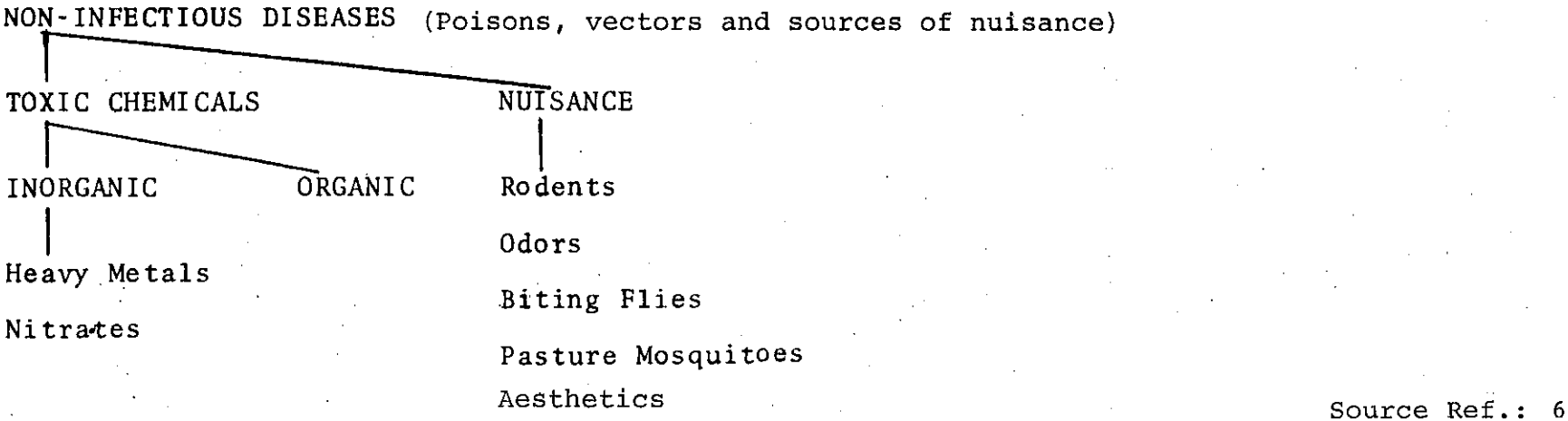


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FIGURE 2. PUBLIC HEALTH PROBLEMS ASSOCIATED WITH WASTEWATER

TABLE 3

AVERAGE POLLUTANT DISCHARGE IN HOUSEHOLD

WASTEWATER[1/], Mass/Capita/Day[2/]

Pollutant Study	Olsson	Wallman	Ligman	Laak	Bennett	Siegrist	Mean GPCD	Mean mg/1
BOD_5	45.0	-	48.1	48.6	34.8	49.6	45.2	260
Suspended Solids	48.0	-	46.3	-	47.3	35.1	44.2	260
Nitrogen	12.1	-	16.8	-	7.2	6.1	10.6	62
Phosphorus	3.8	-	4.1	-	-	4.0	4.0	23
Flow, GPCD	52.1	52.0	46.0	41.4	43.7	36.5	45.3	-

1/ The results are for households with typical appliances excluding garbage disposals. Source Reference: 3

2/ All pollutant contributions are expressed in grams/capita/day except flow, which is in gallons per capita per day, and the mean concentration, which is in mg/1.

TABLE 4

BACTERIOLOGICAL QUALITY OF HOUSEHOLD SEPTIC TANK EFFLUENT[1]/, BACTERIA/100 MLS

Organism	Data Points	Mean[2]/	95% Confidence Interval
Fecal Streptococci	97	3800	2000 - 7200
Fecal Coliform	94	420,000	290,000 - 620,000
Total Coliform	91	3,400,000	2,600,000 - 4,400,000
Pseudomonas aeruginosa	33	8,600	3,800 -19,000
Total Bacteria	88	34×10^7	$25 - 48 \times 10^7$

1/ The results are for samples from septic tank effluents at five residences. Source Reference 3.

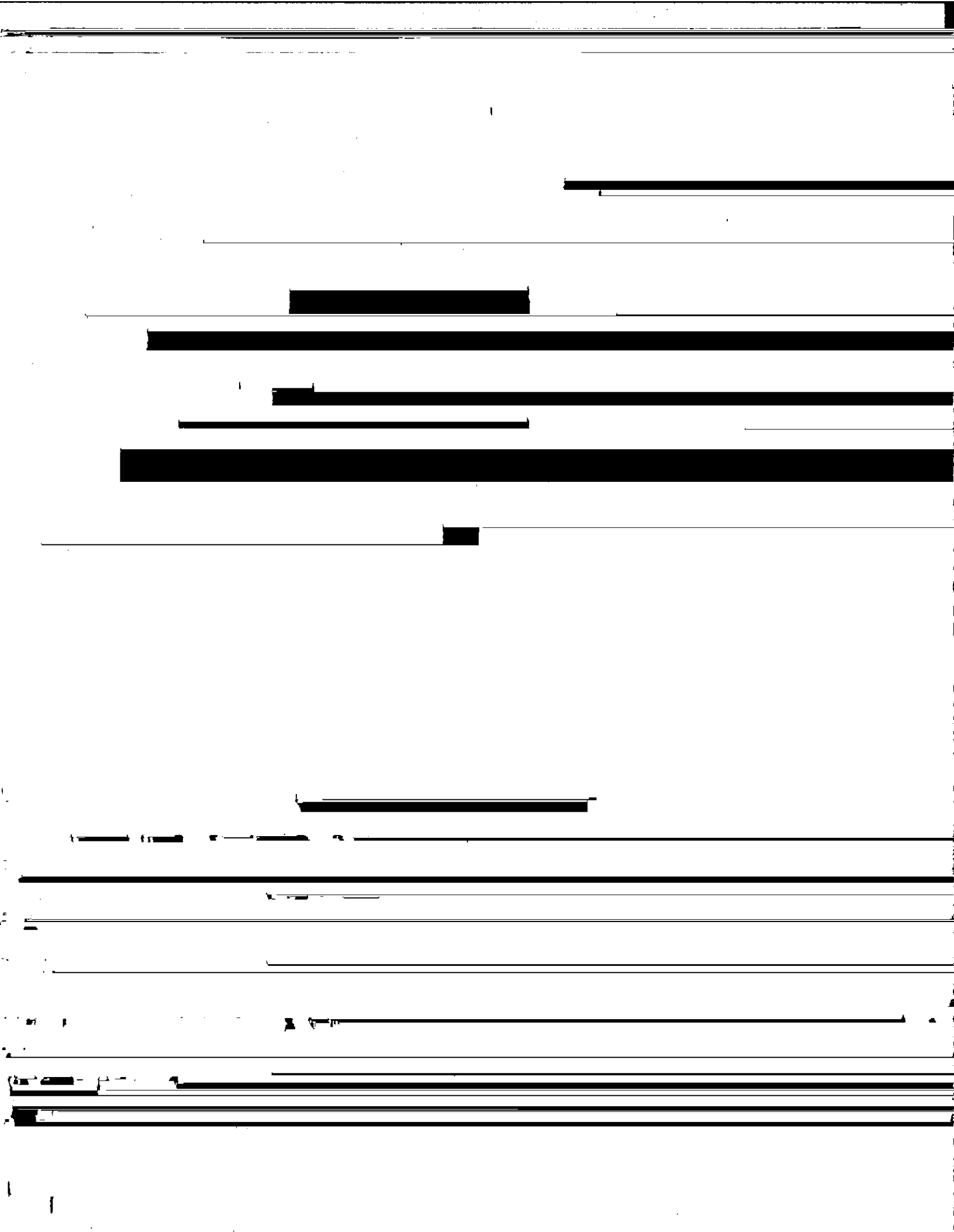
2/ Log normalized data.

TABLE 5

POLLUTANT DIVISION BETWEEN THE BLACK AND GREY WASTEWATER STREAMS[1/]

	GREY			BLACK		
	Percentage of Total Pollutant		Mean Concentration	Percentage of Total Pollutant		Mean Concentration
POLLUTANT	Mean	Range	mg/l	Mean	Range	mg/l
BOD_5	63	51-80	255	37	20-49	280
Suspended Solids	39	23-64	155	61	36-77	450
Nitrogen	18	1-33	17	82	67-99	145
Phosphorus	70	58-86	25	30	14-42	20
Flow	65	53-81	-	35	19-47	-

1/ The values shown are based on the results of the studies shown in Table 3. The results are average values for households with typical conventional appliances excluding the garbage disposal. Source Reference: 3.



Greywater has a noticeably different physical and chemical composition from that of blackwater (Table 5). Typically, greywater contains about two-thirds of the flow, BOD and phosphorus and one-third of the suspended solids. Blackwater contains about 70 percent of the suspended solids and 80 percent of the nitrogen found in combined wastewater. Table 6 compares the bacteriological content of greywater to that of combined septic tank effluent. A review of Table 6 indicates that greywater contains substantially fewer of all bacterial organisms investigated than septic tank effluent. It shows that greywater contains a substantially lower concentration of disease agents than combined wastewater if someone in a particular household were shedding these agents. This remains true in spite of the fact that bacterial counts can be greatly reduced by sedimentation in a septic tank.

In view of the general lack of viral evaluation of wastewater, a great need exists to investigate the viral content of greywater. This will be no easy task considering the many viral types present in wastewater with many requiring an independent evaluation procedure.

3. Host Response

The reaction of a host after encountering a dose of disease agent is dependent upon his physical health, specific acquired immunity, method of disease agent entry, dosage and the relative strength or toxicity of the disease agent. The host response can range from no effect to death. There is little information available to indicate the number of enteric bacterial agents required to induce clinical illness in the human host. In some instances, the host may contact an insufficient dose of a given agent to result in clinical illness but he could become a carrier of disease.

Due to the lack and difficulty of study on virus and parasitic effects on the human host, there is little firm data. This is a major area for controversy and hence for further investigation.

4. Agent to Host Contact

The final consideration is the requirement that the host make contact with the disease agent resulting in a sufficient dose to cause illness.

Clearly, should such contact be avoided, the host cannot contact the disease regardless of the agent numbers present, their relative strengths or the host's physical condition.

If one can prevent the host from contacting the agent, then the problem of disease prevention or prediction is greatly simplified. Presently, this is the basic disease preventive method used by health agencies when requiring subsurface disposal of any wastewater. The concept of avoiding contact is the best disease prevention measure available when applied to the greywater management process.

B. Public Acceptability of Greywater Use

Public acceptability is a most important consideration when identifying acceptable greywater uses. Past opinion surveys on wastewater use in general indicate an acceptance of reclaimed wastewater for noncontact uses. The objections increase for contact applications such as swimming and bathing (8 & 9). A survey conducted by William H. Bruvold, University of California, Berkeley, in 1972 polled the public attitude toward the use of reclaimed water (9). The Bruvold study examined only the attitudes of persons toward the uses of reclaimed water. This may be distinguished from greywater use in that greywater usage requires that the homeowner undertake the actual collection, treatment and usage of the water. This would require a greater dedication to water reuse.

Little information is available specifically on greywater use. A survey by the State of California Department of Water Resources (DWR) polled persons in Marin County during 1976 and 1977 on residential greywater use (10). The DWR poll addressed itself specifically to greywater use in and about the home. While this study was made during the drought in Marin County, a county hard hit by the drought, it does demonstrate a dramatic increase in the use of greywater resulting from the extended drought and resulting in increased greywater awareness. Some of these systems will be allowed to continue operation on a permanent basis following the drought.

The results of the survey by Bruvold in 1972 are shown in Table 7. This study investigated six communities in southern California and four communities in northern California. The survey interviewed a total of 972 people. The participants were fairly similar in their backgrounds, most were high school graduates, of average economic level, and about 40 years of age. There was a knowledge on behalf of the participants that the reclaimed water

TABLE 7

PERCENTAGE OF RESPONDENTS OPPOSED TO USE OF RECLAIMED WATER[1/]

		California Location		
		Northern (N=386)[2/]	Southern (N-586)[2/]	Total (N=972)[2/]
1.	Drinking water	55.0	57.3	56.4
2.	Food preparation in restaurants	53.4	57.7	56.0
3.	Cooking in the home	52.5	55.8	54.5
4.	Preparation of canned vegetables	52.5	55.1	54.1
5.	Bathing in the home	37.8	39.2	38.7
6.	Swimming	24.8	23.0	23.7
7.	Pumping down special wells	26.1	21.4	23.2
8.	Home laundry	21.1	23.9	22.8
9.	Commercial laundry	19.4	23.5	21.9
10.	Irrigation of dairy pasture	15.6	13.1	14.1
11.	Irrigation of vegetable crops	15.6	13.0	14.0
12.	Spreading on sandy areas	13.2	13.3	13.3
13.	Vineyard irrigation	14.0	12.1	12.9
14.	Orchard irrigation	10.7	9.7	10.1
15.	Hay or alfalfa irrigation	8.3	7.0	7.5
16.	Pleasure boating	9.1	6.1	7.3
17.	Commercial air-conditioning	7.8	5.6	6.5
18.	Electronic plant process water	6.0	4.1	4.9
19.	Home toilet flushing	3.9	3.7	3.8
20.	Golf course hazard lakes	4.4	2.2	3.1
21.	Residential lawn irrigation	2.3	2.9	2.7
22.	Irrigation of recreation parks	2.8	2.4	2.6
23.	Golf course irrigation	1.8	1.5	1.6
24.	Irrigation of freeway greenbelts	1.8	0.9	1.2
25.	Road construction	1.6	0.3	0.8

1/ Source Reference: 9

2/ N = Number of respondents

The survey investigated the reasons for supporting reclaimed wastewater for some uses and not for others (Table 8). The respondents' primary concern was that wastewater use was psychologically repugnant and that the water was felt to lack purity. The results of Table 8 indicate that a psychological barrier to change exists. Traditionally, fresh water is used for all household uses. The American family grows up with the idea that all things associated with waste are "dirty" (11). Thus, it is clear that the majority of objections to wastewater use are cultural.

The attitudes toward greywater use are changing in California because of the drought of 1976 and 1977. The study conducted by DWR indicated a dramatic increase in the use of greywater between the drought years of 1976 and 1977 (10). Many of the communities in Marin County are dependent upon limited surface water sources for their water supplies. As the flows to these sources decrease, a concerted effort was made to conserve water. Likewise, other areas of California undertook voluntary conservation programs and the use of greywater was increasingly applied in drought affected areas of California. The changing attitudes of much of California were depicted by the DWR Marin County study (Table 9). This study indicated that greywater use from the bath increased from five percent in 1976 to 35 percent in 1977. The laundry water reuse increased from five percent of the respondents in 1976 to 14 percent in 1977. Dish water reuse increased from three percent in 1976 to seven percent in 1977.

The second portion of the table indicates the greywater uses investigated. The table indicates that landscape and garden watering was used by 37 percent of the respondents and toilet flushing was close at 32 percent. A dramatic jump from 14 to 32 percent for the study period was noted for greywater used for toilet flushing. This would indicate that the continuing drought and increasing awareness of this use were responsible for the increased application. The unspecified use category decreased from 53 to 43 percent during the two years indicating either a greater awareness and acceptance of individual uses for greywater or a willingness on behalf of the user to specify the uses made of greywater. This study clearly shows an increased application of greywater use from 1976 to 1977 in Marin County.

The drought caused Californians in general to use and learn more about greywater, especially in the rural communities using limited water sources. After the drought much of the focus on greywater may be forgotten. For the present, however, the increased awareness of the benefits of greywater use will be remembered in drought susceptible communities and greywater research will continue as need dictates. Some local regulations were changed to allow greywater usage on a permanent basis as a consequence of the drought.

TABLE 8

REASONS FOR OPPOSITION TO USES OF RECLAIMED WATER[1/]

Reason	Percent Stating Reason and Location		
	Northern (N=386)[2/]	Southern (N=586)[2/]	Total (N=972)[2/]
Psychologically repugnant	29.0	29.4	29.2
Lack of purity	27.2	17.7	21.5
Can cause disease	9.3	10.1	9.8
Bodily contact undesirable	9.8	6.8	8.0
Undesirable chemicals added	6.2	4.4	5.1
Taste and odor problems	3.1	4.4	3.9
Cost of treatment unreasonable	1.6	0.3	0.8
TOTALS	86.2	73.1	78.3

1/ Source Reference: 8

2/ N = Number of respondents.

TABLE 9

WATER REUSE IN MARIN COUNTY, CALIFORNIA 1976-1977 [1]

Respondents Reusing Water by Category

	1976 Number	1976 %	1977 Number	1977 %
Respondents	695	70[a]	930	93[a]
Water Use Category				
Bathing	36	5[b]	323	35[b]
Laundry	34	5[b]	132	14[b]
Dishwashing	20	3[b]	64	7[b]

Households Using Greywater or Reusing Household Water

	1976 Number	1976 %	1977 Number	1977 %
Respondents	350	35[a]	808	81[a]
Greywater Uses				
Unspecified	187	35[a]	346	43[b]
Toilet Flushing	48	14[b]	255	32[b]
Plants & Garden	122	35[b]	297	37[b]
Cleaning	--	--	21	3[b]
Reuse Cold Water from Hot Tap	13	4[b]	42	5[b]

[1] Source Reference: 10

[a] Percentage taken over total questionnaires sent (1000)

[b] Percentage taken over total number of respondents

Once the health concerns of greywater use are resolved, a slow adjustment of people to greywater use will continue and will require education, time and water-short periods caused by drought or increasing demands to emphasize the benefits of water conservation before the general public will adjust to the general use of greywater.

C. Available Equipment for Greywater Treatment

The use of greywater in and around the home necessitates some form of collection followed by treatment commensurate with the intended use.

1. Collection

Collection of greywater takes forms ranging from simple bucket dipping of the water from the laundry or kitchen sink and hand carrying to the use to a completely separate collection system permanently joining all appliances producing greywater for use.

The selection of a particular collection method may be determined by the permanence of the installation. This document will restrict the discussion of greywater collection to permanent installations using a separate gravity collection system or a pressure collector relying on small collection pumps at each greywater source.

2. Treatment

Presently, rural wastewater treatment may be nonexistent or may involve processes producing an effluent superior to the existing drinking water standards, although drinking water use is not acceptable in California. Generally, there is a direct increase in cost with increasing treatment and hence a correlation of cost with treated greywater quality. The degree of treatment must be dictated by reasonable standards (yet to be developed).

The following treatment systems are in the developmental stage in California and the effluent quality and system operation require further study prior to specifying uses. The discussion will address those systems providing the least amount of treatment and then progress to those systems capable of more complete treatment.

a. Direct Use (no treatment)

The direct use process simply takes the collected greywater and directs it immediately to its intended use. This process could include greywater storage prior to use with some treatment

by sedimentation. This system poses the threat of user contact with essentially untreated greywater and is generally opposed by health officials except on a temporary drought emergency basis and then only for ornamental shrub watering. Subsurface irrigation is allowed by some county health departments. The use of raw unsettled greywater could result in clogging the subsurface irrigation line.

b. Septic Tank Treatment with Subsurface Disposal (No direct use of greywater)

This category is included only because it is the process presently approved on a general basis for greywater management because there is no possibility for human contact with the treated effluent. The primary disadvantage is that no direct use benefit is made of the effluent. It presents no wastewater management advantages over septic tank treatment of combined wastewater and, like the septic tank system, provides health officers with the assurance that the user will not contact the greywater. In some cases vegetation has been planted over the subsurface disposal area thereby making an indirect use of the wastewater while enhancing its disposal

to be reduced (3). With chlorination, this process could provide water quality essentially free of bacterial contamination. Further demonstration of this process is required before health officials would consider its general application.

e. Special Processing for Complete Use

Facilities are available which utilize advanced treatment process which are capable of producing an effluent exceeding drinking water standards from combined wastewater. As with treatment systems producing lower quality effluent, the use of these treatment systems remains to be approved by health agencies in California. The logical application of this system would be for complete in-house use. These systems are newly developed and presently have not been authorized anywhere in the State of California.

The performance-cost information for various typical systems is summarized in Table 10.

The systems presented include most of the available treatment system components but do not represent all of the possible arrangements of system components. An example is the alternative presented at the bottom of Table 10 which utilized filtration and soil contact in a greenhouse environment for food production. Greywater will require study before health agencies will authorize its use for food crops. This is particularly true should greywater be used for root food crops.

The costs and components shown represent the present general greywater treatment system types producing progressively superior effluent. The reader is referred to the Phase I report of the Rural Wastewater Disposal Alternatives study by the Governor's Office of Appropriate Technology, pp. 38-41, for a more detailed discussion of greywater treatment components.

D. Present Greywater Use Policy in California

Regulation of individual on-site wastewater management (of which greywater is a part) is under the jurisdiction of county health departments. Prior to the 1976-1977 drought emergency, it was illegal in every county in California to utilize greywater due to a lack of use, study, and fear of the potential health hazards posed by its use. During the drought, some counties modified ordinances on greywater use or simply developed an informal policy of "looking the other way".

TABLE 10
TYPICAL GREYWATER TREATMENT SYSTEMS PERFORMANCE - COST INFORMATION
(Family of Four)
1978

System	Final BOD mg/l	Final F. Coll., MPN/100	Virus Statement	Routine Agency Maint. Req'd. 1/	Capital Cost, $ 3/	O&M Cost, $ 4/	Annual Cost, 8% 20 yr. $	Monthly Cost $
1. Coll. & Direct Reuse	250	700	No Removal	None	None	None	None	None
2. Coll., Septic T. & Sub-Soil Disp.	250	700	Min.removal	1 h/yr.	1600	30	190	16.00
3. Coll., Screening & Filtration	No data	No data	No data	5 h/yr.	700	60	160(10 yr.)	13.30
4. Coll., Septic T., & Sand Filtration	<4-10 mg/l 2/	190 2/	1-2 Log_2 Reduction	9 h/yr.	2050	100	300	25.00
5. Coll., Screen, Sand Filter & Chlorination	No data	No data	No data	9 h/yr.	2000	100	300	25.00
6. Coll., Bio React., Filter, Carbon, Ion Ex. & U.V.	Meets Drinking Water Standards			Contract $20/mo.	5000	240	750	63.00
7. Coll., Bio React., Aero-Anaer., Filter, Chlor., Ozone, Rev. Os., Ion Ex., & U.V.	"	"	"	"	Comparable to above.			
Alternative								
1. Coll., Rough Filter, Soil Box-Plants w/Underdrain	No data	No data	No data	9 h/yr.	2000	90	300	25.00

1/ Labor estimated from general literature and charged at $10.00/hr. (incl. overhead).

2/ Determined with combined waste.

3/ Septic tank: $800; Reduced size leach field: $800; Pump & Controls w/Small Sump: $400.

4/ Labor Cost @10/hr.; Standard Fee of $70 every 4 yr. to pump tank; Energy @ $10/yr.

Source: Primary

The State Department of Health Services released a statement during the drought that authorized greywater use on an emergency basis only. The State recommended that greywater use be allowed only in areas where extreme shortages existed, other conservation measures were previously implemented and no other water was available for home irrigation. The state policy emphasized that all greywater uses needed approval from local health agencies. The Department of Health Services stated that the use of greywater was "a step backward in community sanitation" and was "not acceptable except in an emergency situation".

Since the drought, many of the water conservation devices such as flow restrictors, toilet tank dams, etc., have remained.

A recent telephone survey by the State Department of Health Services Sanitary Engineering Section reveals present greywater policies held by most counties in California (12). A summary of the results of this survey is shown in Table 11. Most counties (60 percent) maintain policies which completely prohibit the use of greywater with the same standards as held by all counties before the drought. Most counties in this category cite the uniform plumbing code (UPC) which prohibits the use of greywater. Some in this category indicated that they would be willing to alter their policy should the State take a firm position on the use of greywater or should the UPC change. The counties in the other categories permit greywater systems under some conditions (40 percent). Policies in all of these counties were changed primarily as a consequence of the drought. While 15 percent allow the use of greywater under restrictive experimental conditions, 5 percent allow greywater systems through specific local regulations acquired since the drought which specify local use conditions. In general, the drought has clearly resulted in the increased allowable use of greywater in times following the dry conditions.

E. Suggested Regulations and Policy Required for Greywater Use

Little information is known on greywater use and public health and safety. Historically, our culture was accustomed to the use of water of drinking quality for all purposes and the belief that once water was used in the home, it was unfit for reuse and should be effectively disposed as far from its initial use as possible. To compound the problem, little effort has been made to collect data which are needed to specifically identify those treatment systems with a resultant effluent quality commensurate with specific greywater uses. The drought provided California with the opportunity to focus attention on the benefits of, and in some areas the necessity for, water conservation. As a consequence of the increased

TABLE 11

SUMMARY OF

PRESENT LOCAL AGENCY GREYWATER POLICIES[1/]

General Policy[2/]	Number of surveyed Counties Holding This Policy	Percent of Total Surveyed
1. Do not allow the use of greywater under any circumstances. Cite the uniform plumbing code which forbids the use of greywaters.	34[3/]	60
2. Actively discourage greywater systems but will allow an occasional experimental system under unusual conditions.	15	28
3. No formal policy is held toward greywater systems, do allow some experimental systems.	4	7
4. County authorizes greywater usage in some areas and under special conditions.	3	5
TOTALS	56	100

1/ Telephone survey by Karol Enferadi, Department of Health Services, Sanitary Engineering Section, July and August 1978.

2/ Most counties encouraged the use of water conserving devices especially those prohibiting the use of greywater.

3/ Includes 16 counties which contract health services. Policies vary, however, most do not allow the use of greywater under any conditions.

focus of attention on water conservation, the benefit
and potential health hazards of greywater use are issues

The duties of the typical on-site management district are then clear: approve design and construction of on-site systems, routinely inspect systems for maintenance and require such when needed, and identify failing systems (surfacing effluent) and ensure their prompt repair.

The management of greywater systems is not so easy. Like on-site wastewater system management, a local agency would be needed for approval of design and construction, and inspection; however, problems arise in two areas:

1. Routine system inspections

   Since there are so many different types of greywater systems and since their effluent qualities vary from system type to system type, the frequency and type of maintenance vary as do the solids handling aspects of the many systems. The inspectors would be required to familiarize themselves with the varied system types and establish monitoring frequency dependent upon system type and use. This work could involve some very detailed procedures.

2. Greywater Misuse

   With the development of requirements based on acceptable use compatible with system effluent quality, the problem of greywater misuse arises. How does the local regulatory agency effectively deal with use consistent with effluent quality? Public health officials have already pointed out the increased danger of cross-connection in structures plumbed with both potable and nonpotable

manner prior to endorsing any effective greywater usage program. If cooperation does not exist between the local agency and the system user, effective greywater use cannot occur.

F. User Education

Greywater system operation requires an informed user who desires proper greywater management. The accumulating technical information on greywater systems and their health evaluation should be consolidated into a training package for local agencies and individual users. The training material must be concise and written in simple terms understandable to the lay person while emphasizing the benefits and risks of greywater use.

The greywater management program suggested below would authorize the use of a greywater system only after the user passes an examination on the operations and risks involving greywater use. This concept is analogous to the privilege of operating a motor vehicle. The user would be informed on the local system of greywater management and would be issued a greywater permit after passing the examination and paying the necessary fees.

G. Suggested Management Approach

The following discussion outlines the general procedures for an effective greywater use program which will ensure proper greywater utilization commensurate with system effluent quality. The program is one suggested approach to effective greywater management. However, any greywater use program will require an educated user working closely with the local regulatory agency. The specific details of any greywater management program will require additional health risk investigations and formal policy guidelines adopted by the local health officials. The program details could then be prepared and executed under the legislative framework similar to SB 430 with modifications as necessary.

The suggested approach to greywater management would be for the local agency to routinely inspect the systems and maintain files as provided under legislation currently available to on-site wastewater management districts to ensure that the user's system is working. An operation permit is issued for each approved system. The operation permit is updated following inspection of a properly functioning system or the proper mitigation of a failure. The greywater use permit would list the standards required of the effluent commensurate with intended use. Should the inspector determine improper use, the user could be required to dispose of all wastes underground with the loss of his permit for a greywater system. This would mandate the construction of a subsurface disposal system should an existing unit having sufficient capacity be

unavailable. The area for this system would be reserved prior to the issue of the original permit; however, construction would not be required until a loss of the greywater use privilege.

Management operations are facilitated by use of the permit system since greywater use would be viewed as a privilege not a right. The use permit would be revoked if any of the following occur:

(1) The user fails to notify and initiate repair of his malfunctioning greywater system within a reasonable period of time (usually two weeks).

(2) Failure on the part of the homeowner to execute proper and timely system maintenance.

(3) Improper use not in accord with the usage allowed under the permit.

To identify the above points, inspections would be made a specified number of times throughout the year but would be unannounced in the same way as readings are taken on a utility meter. Samples would be taken from specific locations provided for this purpose.

Should the inspector find effluent quality inferior to that required for the permitted use, the permitted greywater use identified on his permit would be restricted to bring it into accord with measured greywater quality, the system treatment would be required to be improved or the user would lose his permit.

Program funding would be provided by routine permit fees which would support the greywater inspection and monitoring program. Unlike the septic system on-site monitoring and inspection program for combined wastewater systems, continually malfunctioning greywater treatment systems could be shut down. In this case, all greywater would be directed to an on-site subsurface disposal system constructed in an area reserved for this purpose at the time the permit was granted or to an existing system provided it is of sufficient capacity. This could necessitate the use of water conservation appliances in areas with limited available land for the construction of the replacement system.

III. SUMMARY AND CONCLUSIONS

Greywater use in the home is technically feasible. A review of existing devices shows that devices are available to provide any degree of treatment desired. Cost increases with the degree of treatment provided. In addition, system complexity also increases with a corresponding advance in maintenance requirements and energy. The present dilemma concerning greywater is centered around identifying how much treatment would be required for an intended use. Presently, California prohibits complete home recycling systems, and greywater use is allowed only in a very few counties.

There is a need for additional work on the health aspects of greywater in relation to home use. Local health officers are charged with the responsibility of protecting the public health and safety and the prevailing thinking is that all possible direct contact with any wastewaters must be avoided. Concerns range from problems associated with illness to the possibility of cross connections between the greywater use systems and the potable water supply. To further complicate the problem the regulation requirements for the effective management of greywater systems have not been previously identified.

The implementation of greywater use systems will increase in the future with the provision of the badly needed health risk data. A workable management program needs to be developed which might involve a permit-fee basis administered at the local level by a local on-site wastewater management district. Due to the large variations in equipment types and maintenance requirements, all maintenance must be left to the user. This document suggests a greywater management program where the local agency assumes strictly a regulatory-monitoring function. This program, as with any effective greywater management program, will necessitate an informed user working closely with the local regulatory officials.

Demonstration projects in conjunction with additional study and the passage of time must occur before greywater use systems become widely accepted in California. Greywater use is an inevitable necessity in many communities, particularly in rural areas, to conserve the decreasing supplies of pure water as the population continues to grow.

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