

# SMALL SCALE WASTE MANAGEMENT PROJECT

UNIVERSITY OF WISCONSIN-MADISON

## PUBLICATION 1.15

### *Minimizing Wastewater Flows – Impacts on Onsite Wastewater Systems*

by

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Citation: Siegrist, R., "Minimizing Wastewater Flows – Impacts on Onsite Wastewater Systems," Small Scale Waste Management Project publication, University of Wisconsin, Madison, Wisconsin, 1982.

(18 pages.)

## MINIMIZING WASTEWATER FLOWS - IMPACTS ON ONSITE WASTEWATER SYSTEMS

By Robert L. Siegrist, P.E.

### ABSTRACT

Wastewater flows from homes, motels, offices and other domestic facilities can be reduced by 50 percent or more with *minimum flow* plumbing technology. These specially designed fixtures and appliances minimize event water use and wastewater flows while providing satisfactory user service levels and functional similarity to conventional products. Minimizing wastewater flows can yield benefits to onsite wastewater systems by eliminating hydraulic overloads, extending component service life, reducing operation and maintenance needs, as well as enabling reduced component sizing. Additional benefits are derived from reduced water and energy consumption. Experiences to date with minimum flow technology have demonstrated their successful application under a variety of circumstances.

### INTRODUCTION

The wastewater flow volume is a fundamental variable in the design and performance of all onsite wastewater facilities. Minimizing wastewater flows can yield benefits to existing facilities by eliminating hydraulic overloads, extending component service life or reducing operation and maintenance needs. For new facilities, reduced component sizing may be an additional benefit.

This paper presents a discussion of wastewater flow reduction with minimum flow fixtures. Potential impacts on onsite wastewater systems as well as water and energy services are discussed and cost analyses are given

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for several common rural situations. Several examples are presented to highlight the types of situations under which minimum flow fixtures have been successfully applied.

#### MINIMUM FLOW STRATEGIES

Domestic wastewater flows can be reduced by 10 to 15 percent with basic water conservation measures [1-4]. Consumer education, alternative pricing policies, building code requirements and tax credits have been routinely used to stimulate efficient water-use habits and encourage the use of water-saving devices, fixtures and appliances. Far greater reductions in flow can be achieved utilizing alternative plumbing technologies: *minimum flow fixtures or water reuse systems.*

Conventional plumbing fixtures and appliances were developed without serious concern for water-use efficiency. The water and wastewater flows of these fixtures can be reduced somewhat with simple devices such as faucet and showerhead inserts or toilet-tank displacement devices. Beyond these, however, are an increasing array of plumbing products specifically designed to accomplish a traditional task while minimizing the water and wastewater flows. Compared to conventional fixtures, these products provide for 50 to 90 percent reductions in flow rates or volumes. Importantly, they provide comparable user service levels, functional similarity to conventional fixtures, compatibility with existing utility systems and limited operation and maintenance needs. Minimum flow fixtures have been successfully utilized throughout this country. In residential dwellings flow reductions of 30 to 70 percent have been achieved [5-7]. In commercial facilities and recreation developments flow reductions up to 90 percent may be realized [6, 8].

An alternative approach is to collect, purify and recycle onsite the entire wastewater flow or the fractions produced by selected activities. To simplify performance requirements, many reuse systems process only the wastewaters discharged from bathing, laundry and sink usage and restrict the use of the recycled water to flushing toilets and lawn irrigation. At the other extreme, systems are available that process the entire domestic wastewater flow and recycle the effluent as a potable water [9, 10]. Domestic reuse systems typically employ various

combinations of basic and advanced unit treatment processes complemented by specially designed control networks. Typical treatment trains include screening, flow-equalization, biological oxidation, media filtration and disinfection. Chemical coagulation-flocculation, membrane filtration, ion exchange and activated carbon adsorption are also used in various treatment sequences. For many applications packaged proprietary systems are commercially available. Water reuse systems have been used effectively for larger commercial facilities and clustered residential developments yielding flow reductions up to 95 percent [11-14]. For individual homes their high capital cost and installation, operation and maintenance needs have limited their utility [15].

While both strategies can facilitate major reductions in domestic water use and wastewater production, there are important differences between them. Minimum flow fixtures are simply specially designed plumbing products. They utilize water from the potable supply and the wastewater produced is conveyed from the structure for treatment and disposal. Primary concerns are for the performance of the product with regard to cleaning and waste transport functions, installation, operation and maintenance needs, cost-effectiveness and user acceptance. During development of these types of products, these concerns have been addressed and experience to date has demonstrated their successful application.

Water reuse systems employ treated wastewater as the cleaning and waste transport medium rather than potable water. Conventional plumbing fixtures are typically employed but additional plumbing components are required including a set of purification processes and a separate in-house collection and distribution network for the recycle water. In addition to the concerns expressed for minimum flow fixtures, an overriding concern when dealing with wastewater recycling regards the potential health hazards. Mitigation of this public health concern is very difficult as it must rely on adequate performance capabilities of the recycle system for the wastewater to be recycled, proper operation and maintenance, avoidance of cross-connections with the potable water supply, and proper use of the recycle water. Development and application of domestic water reuse systems have attempted to address these concerns and

successful applications have occurred. However, potential health hazards are a reality, particularly in small, isolated applications with potentially poor management controls.

Application of minimum flow fixtures will generally be more appropriate than water reuse systems for minimizing water use and wastewater flows at individual homes and other isolated facilities. The minimum flow fixtures will usually be simpler to install, require lower operation and maintenance, present no public health hazards, and possess a lower cost per unit of reduced flow.

#### FLOW VOLUMES WITH MINIMUM FLOW FIXTURES

Flows for conventional plumbing fixtures and selected minimum flow fixtures are shown in Table 1. In Table 2, flows for two plans involving minimum flow fixtures are compared to those for conventional fixtures. Plan A includes a very low-volume toilet, low-flow showerhead, front-loading clotheswasher and faucet aerators. Plan B incorporates an air-assisted low-flush toilet and showerhead, but otherwise is similar to Plan A. Projected reductions in the total daily flow are 60 percent and 66 percent with Plan A and B, respectively, while projected reductions in hot water use are 47 percent and 53 percent (Table 2).

For commercial establishments, recreational developments and other domestic facilities, it is extremely difficult to delineate typical water and wastewater flows due to potentially large variations in the plumbing fixtures present and their usage characteristics. To develop projected flow reductions for a given facility one must estimate the total daily flow and the breakdown between the various water-using activities. Then by using typical flows for conventional fixtures and appliances and those for minimum water-use fixtures (Table 1), an estimate of the projected reduced flow can be achieved. Toilet flushing and sink usage are common activities in many commercial facilities with bathing less frequently encountered. The flows generated by these activities can be reduced dramatically and, in turn, the total daily flow.

Table 1. Example Minimum Flow Fixtures

Activity/Type	Flow	Expected Flow <sup>†</sup> Reduction (%)	Example Manufacturer/Distributor <sup>††</sup>
<u>Toilet</u>			
Conventional	4-6 gal	0	-
Blow-out	0.8-1.4 gal	24-29	Ifo Sanitaire, Sweden; Thetford Corp., M
Air-assisted	0.5 gal	31	Microphor, Inc., CA
Macerator	0.4 gal	32	Monogram Ind., CA
Foam-assisted	0.1 gal	35	Nepon, Inc., Japan
<u>Shower</u>			
Conventional	4-6 gpm	0	-
Flow-limiting	1.8-2.4 gpm	7-9*	Ecological Water Prod., RI
Air-assisted	0.5 gpm	12*	Minuse, Inc., CA
<u>Laundry</u>			
Conventional	34-50 gal	0	-
"Suds-saver"	26 gal	7**	MayTag
Front loading	22 gal	8	Westinghouse
<u>Sinks</u>			
Conventional	2-4 gpm	0	-
Aerator	1.75 gpm	6	Ecological Water Prod., RI
Flow Control	1.5 gpm	7	Dole Co., IL

<sup>†</sup> Expected reduction in total daily home water use (interior) and wastewater flows.

<sup>††</sup> For illustrative purposes only, not intended as an endorsement.

\* Assumes 67% of bathing is performed through showering.

\*\* Assumes "sudsaver" option used for 50% of laundry loads.

Table 2. Home Water and Wastewater Flows with Minimum Flow Fixtures

Activity	Conventional			Alternative Plan A			Alternative Plan B		
	Event Use	Daily Flow, gpd		Event Use	Daily Flow, gpd		Event Use	Daily Flow, gpd	
		Total	Hot*		Total	Hot		Total	Hot
Toilet	5.0 gal	80.0	0	0.8 gal	12.8	0	0.5 gal	8.0	0
Bath	25.0 gal	10.0	5	25.0 gal	10.0	5.0	--**	--	--
Shower	5.0 gpm	30.0	15	1.8 gpm	10.8	5.4	0.5 gal	3.0	1.5
Laundry	37.0 gal	40.0	20	22.0 gal	23.8	11.9	--	--	--
Kitchen	3.0 gpm	27.0	17	1.5 gpm	13.5	6.8	--	--	--
Lavatory	3.0 gpm	8.0	4	1.5 gpm	4.0	2.0	--	--	--
Utility	3.0 gpm	5.0	3	3.0 gpm	5.0	3.0	--	--	--
TOTAL	--	200	64	--	79.9	34.1	--	67.3	30.2
% REDUCTION	--	0	0	—	60%	47%	--	66%	53%

\* Hot = 140°F

\*\* Same as Plan A

#### IMPACTS ON ONSITE WASTEWATER SYSTEMS

##### Raw Wastewater Composition

Reducing the wastewater flow volume without corresponding reductions in the pollutant mass contributed will result in increases in the concentration of pollutants in the raw wastewater stream. Based on a simple mass balance, the following relationship can be used to predict the increased concentration of pollutants associated with a given level of flow reduction:

$$C_R = \frac{C}{1-R} \quad (1)$$

where,  $C_R$  = concentration under a reduced flow, mg/L

$C$  = concentration under a normal flow, mg/L

$R$  = reduction in flow expressed as a fraction (0-1.0).

For a 40% reduction in daily flow, for example, the concentration of a given pollutant is calculated to increase approximately 67% compared to the concentration associated with a normal flow.

The use of certain types of minimum flow fixtures may also affect the composition of the raw wastewater due to the nature of their operation. This effect is primarily associated with minimum flow toilets. For example, two types of toilets either incorporate a burst of compressed air or have an integral grinder pump, in both cases to reduce the particle size of the waste solids and facilitate their transport with 0.5 gal of water. Yet another type of toilet utilizes a foaming agent added to the toilet bowl to aid in waste cleansing and transport with less than 0.1 gal of water. The effect of these types of operational characteristics on the composition of the daily wastewater discharge from a home or establishment is not known.

#### Wastewater Transport

A concern often expressed over the use of minimum flow fixtures regards the potential for inadequate flows to carry solids in the building drainage piping and sanitary sewers. Actual research of this topic has been limited. The results of a laboratory study [16] indicated that a washdown toilet with a flush volume of only 1.5 gal had little or no affect on waste transport in conventionally sized building drains. A recent study sponsored by the National Bureau of Standards demonstrated similar results [17].

Considerable field experience with a number of individual homes and establishments employing a variety of minimum flow fixtures has not revealed waste transport in building drains and sewers to be a problem. Limited experience to date with clusters of home establishments or small communities has also been favorable. For example, a subdivision of 150 homes all of which employ 0.8 gal toilets, faucet flow restrictors and low-flow showers has experienced no collection system problems in over 1 1/2 years of operation. However, one could speculate that as the size of the service area increases, the potential for problems with sedimentation and odors in conventional gravity sewers might reasonably be expected to increase due to increased sewer sizing, reduced slopes and longer reaches.



### Septic Tank Performance

Pretreatment of raw wastewater is commonly accomplished with one or more septic tanks, their primary function being to separate settleable solids and floatable materials from the liquid waste stream and provide for storage and digestion of these materials. There is much speculation as to the effect of minimizing wastewater flows on the performance of septic tanks, particularly regarding the effluent quality produced. In a recent study [7] three rural homes partially outfitted with minimum flow fixtures achieved wastewater flow reductions of 29 to 40% (Table 3). As a result, the concentrations of pollutants in the septic tank effluents increased somewhat (Table 3). However, the increases measured for nearly all parameters were considerably less than those predicted based on a simple mass balance assuming constant removal efficiency in the septic tank. While limited, these data suggest that the treatment efficiency of conventionally sized septic tanks may be enhanced under reduced flow conditions. This may be due to a number of factors including an increased residence time, reduced influent surge flows, and reduced influent temperature fluctuations. Regardless of the specific causes, the concentrations of pollutants in the septic tank effluents (STE) under reduced flow conditions were well within the range of values commonly reported for conventional STE. Similar findings were reported by Rubin [18] for two commercial applications.

Based upon the available data base, it appears that minimizing wastewater flows will not adversely affect the performance of conventionally sized septic tanks. However, it would seem prudent to maintain conventional septic tank sizing and benefit from the improved treatment provided.

### Soil Absorption Systems

The prevalent form of treatment and disposal of septic tank effluent is via a subsurface soil absorption system. As discussed previously, the concentrations of most pollutants in septic tank effluent are increased somewhat under minimizing flow conditions, though they appear to remain within the range of values associated with conventional septic tank effluents. Thus, minimizing waste flows should reduce the hydraulic and pollutant mass loads applied to a conventionally sized soil absorption

Table 3. Impact of Flow Reductions on Septic Tank Effluent Concentrations\* [7]

Home	Daily Flow Reduction %	Parameter (mg/L)					
		COD		TSS		TKN	
		Before**	After	Before	After	Before	After
2	29.1	551 <sup>†</sup>	613	87	108	76	90
		460-642	553-673	52-112	77-139	66-87	83-98
4	34.0	439	578	123	114	90	107
		410-467	544-612	94-153	92-137	77-102	100-114
7	39.8	308	402	62	67	61	66
		266-350	361-444	36-88	60-75	49-72	57-75

\* Adapted from Reference 7. Minimum flow fixtures employed:  
 Home 2 - 0.5 gal toilet; 2 gpm shower; 1.5 gpm aerators (bathroom)  
 Home 4 - 0.5 gal toilet; 1, 2 gpm and 1, 0.5 gpm shower; 0.5 gpm aerators (bathroom)  
 Home 7 - 0.5 gal toilet; 2 gpm shower; 0.5 gpm aerators (bathroom)

\*\* Before data collected June 2 - August 20, 1980; After data collected November 3 - December 17, 1980 and January 5 - February 18, 1981

<sup>†</sup> Mean over 95% confidence interval

system. This should not adversely affect, but would more likely, benefit the operation and service life of the system.

Reducing the size of a new soil absorption system to account for a reduced wastewater flow due to minimum flow fixtures appears to be a reasonable practice. In conventional system design, extremely conservative flow estimates are routinely used to size soil absorption systems and this often results in gross over sizing. For home systems, increased sizing over average flow conditions often reaches 300% or more [9]. This "factor of safety" is retained in the design of soil absorption systems for reduced flows since the reduced sizing is based upon a reduction from conventional requirements. Recognizing that a reduced sizing is not as risky as it might at first seem, more and more states are allowing this practice.

#### Alternative Treatment Systems

A variety of alternative unit processes are available for use in onsite wastewater facilities (e.g., aerobic package plants, sand filters, ...).

The effects of minimizing wastewater flows on the performance of these alternative systems is presently unknown. Since most of these processes are used to treat septic tank effluent, one can speculate that the effects of minimizing flows on a conventionally sized unit process should be beneficial while reduced system sizing in proportion to the reduced hydraulic load and/or pollutant mass load may be appropriate for new systems.

### Holding Tanks

Wastewaters may be collected and contained onsite, and then transported off site for subsequent treatment and disposal, typically via land spreading or discharge into a municipal sewerage facility. Obviously, the frequency of pumping a holding tank is directly proportional to the wastewater flow volume. Thus, minimizing wastewater flows would also minimize the pumping frequency. While the holding tank pumpage would be more concentrated under minimum flow conditions compared to normal flow conditions, it would be far less concentrated than any septic tank pumpage (or septage).

### Management

When considering the impact of minimum flow fixtures on onsite wastewater systems, one must address the issue of user circumvention or removal of one or more of the fixtures. This is an important issue as the performance of an onsite wastewater system may be grossly undermined if the minimum flow fixtures are removed and the wastewater flow increases significantly. This is particularly true for systems that are designed based on an expected reduced flow. Fortunately, the continued use of the types of minimum flow fixtures considered in this paper is very likely as they are sufficiently similar in appearance and operation to conventional fixtures that their use does not require any dramatic user habit changes.

Several management actions can be employed to encourage the continued use of minimum flow fixtures. Prospective users should be made fully aware of the characteristics of each fixture prior to its installation. Users should also be made to realize the potential consequences if they remove or replace the minimum flow fixtures. Installation of the selected

fixtures should be made by competent persons and a post-installation inspection by a management authority staff member may be advisable. Finally to facilitate actual measurement of the wastewater flow volume, a water meter should be installed on the interior water supply system. Quarterly meter readings during the first year of operation followed by annual readings thereafter would confirm that the expected flow reduction was achieved.

### COST ANALYSIS

Minimum flow fixtures are currently more costly than conventional fixtures and thus the benefits accrued to their use must offset this for them to be cost-effective. The potential benefits of minimum flow technology on onsite wastewater systems were described in the previous section. Additional important benefits can be derived from reduced water use and energy consumption, particularly for water heating. The fixture costs and utility savings are influenced by factors which vary not only with the spatial location of the project but with time. The costs of water, wastewater and energy services are rising sharply. Meanwhile, in many cases the costs of the minimum flow fixtures are holding steady, with projections of decreased costs with increased production levels or market competition. These and other uncertainties make it difficult to address the general cost-effectiveness of minimum flow technology. However to provide some insight, an abbreviated analysis of several residential applications was performed. A typical four-member family and a representative home with normal water-using activities and one and one-half baths was assumed (Table 2).

The costs associated with the purchase, installation and operation of the toilet, shower and clotheswasher fixtures are shown in Table 4. Only these three fixtures are shown as they represent significant additional costs over conventional fixtures, while low-flow faucets or faucet aerators do not. The total annual costs of the three conventional fixtures are equal to approximately \$106 while the minimum flow fixtures are more costly at \$152 and \$249 for Plan A and B, respectively.

Representative costs associated with various components of water, wastewater and energy utilities may be found in Table 5. By utilizing

the flow data shown in Table 2, the utility savings due to decreased flows can be calculated. These savings can then be compared to the increased cost of the fixtures to determine potential cost-effectiveness. Recognizing the limitations of a generalized cost analysis, the results shown in Table 6 clearly indicate the potential cost-effectiveness of minimum flow technology in many common situations. For new homes major savings in utility services may be realized, particularly in rural areas where alternative private sewage facilities must be employed. When the minimum flow fixtures have to be retrofit into an existing home their use may be cost-effective only under high utility costs, such as a holding tank situation.

### EXAMPLE APPLICATIONS

#### Single-Family Home

In 1980, a single family home was constructed in a rural area of Wisconsin where slowly permeable soils prevented the installation of a subsurface soil absorption system. As a result, wastewater disposal was accomplished through a holding tank with pumping and offsite disposal. To minimize annual pumping costs, minimum flow fixtures were employed throughout the home: 1.4 gal washdown toilets; 2 gpm showerheads; a sudsaver type clotheswasher; and 1.5 gpm faucet aerators. The daily wastewater flow from the entire six-member family averaged only 67 gal/day, a 75% reduction over the expected flow with conventional fixtures [5]. The residents of this home are pleased with the performance of their minimum flow fixtures. The additional cost of the fixtures (approximately \$600) was offset in less than six months due to the savings in holding tank pumping fees alone.

#### Subdivision

Approximately 260 single-family homes are planned for a 40 acre subdivision near Phoenix, Arizona. Recognizing the need for water conservation and waste flow reduction, the developers chose to employ minimum flow technology in all homes of their subdivision. Washdown toilets (0.8 gal), low-flow showerheads and faucet flow restricters were selected. Since early 1981, approximately 150 homes have been built. There have been no complaints from the homeowners and no problems in the building drains

Table 4. Fixture Costs

Fixture	Type	Cost Item	First Cost	Annual Cost <sup>†</sup>
Toilet	Conventional	Fixtures (2)	\$ 220	\$ 28.92
		Installation	60	7.89
	Blow-out	Fixtures (2)	480	63.11
		Installation	70	9.20
	Air-assist	Fixtures (2)	700	92.03
		Air Compressor	150	19.72
		Installation	150	19.72
		Electricity	-	0.48
Shower	Conventional	Showerhead/Valve	50	6.57
		Installation	60	7.89
	Low-flow	Showerhead/Valve	50	6.57
		Installation	60	7.89
	Air-assist	Showerhead/Valve	260	34.18
		Installation	120	15.78
		Electricity	-	1.00
Clothes-washer	Conventional	Appliance	420	55.22
	Front-loading	Appliance	500	65.74

<sup>†</sup>10% interest over 15 years

Table 5. Water, Wastewater and Energy

Unit	Element	First Cost	Annual Cost <sup>†</sup>
Water	Well Supply	--	\$ 0.15/1000 gal
	City Supply	--	1.00/1000 gal
	Hot Water Heat	--	7.50/1000 gal
Sewerage	City Sewer	--	1.00/1000 gal
Septic Tank	Tank-4.5m <sup>3</sup> (1200 gal)	\$ 600	\$ 70.48
	Installation	150	17.62
	Pumping (\$60/3 yr)	--	20.00
Soil Drainfield	Drainfield	\$ 2.00/ft <sup>2</sup>	\$ 0.23/ft <sup>2</sup>
Pumping Chamber	Tank-3.8m <sup>3</sup> (1000 gal)	\$ 500	\$ 58.73
	Pumping System	400	40.98
	Installation	250	29.37
	Operation	--	30.80
Mound Drainfield	Drainfield	\$ 3.00/ft <sup>2</sup>	\$ 0.35/ft <sup>2</sup>
Holding Tank	Tank-7.6m <sup>3</sup> (2000 gal)	\$ 1100	\$ 129.21
	Alarm	100	11.75
	Installation	200	23.49
	Pumping	--	\$20.00/1000 gal

m<sup>2</sup> = 10.76 x ft<sup>2</sup>; m<sup>3</sup> = 264.1 x gal; <sup>†</sup>10% interest over 20 years used to amortize first costs

Table 6. Annual Cost Savings with Minimum Flow Technology\*

Application**	Utility Costs				Net Savings***		
	Water	Wastewater	Energy	Total	Savings	New	Existing
Reduce Water/ Sewer Costs							
None	70	70	168	308	--	--	--
A	28	28	90	145	163	117	10
B	24	24	79	126	182	39	(-67) <sup>†</sup>
Reduce Soil Drainfield Area							
None	10	367	168	545	--	--	--
A	4	211	90	305	246	194	--
B	4	195	79	278	267	125	--
Remedy Overloaded Drainfield							
None	10	20	168	198	--	--	--
A	4	20	90	114	85	--	(-68)
B	4	20	79	103	96	--	(-153)
Reduce Mound Area							
None	10	933	168	1112	--	--	--
A	4	537	90	631	481	435	--
B	4	495	79	578	534	391	--
Reduced Holding Tank Pumpage							
None	10	1564	168	1743	--	--	--
A	4	724	90	817	926	879	773
B	4	636	79	718	1025	882	776

\* Amortized First Cost and Annual Disbursements, Based upon Tables 2-5 and residency of 350 days/year. Increased fixture costs for Plan A = \$46.02 and \$152.51 for new construction and retrofit, respectively. Increased fixture costs for Plan B = \$142.16 and \$248.65 for new construction and retrofit, respectively.

\*\* Refer to text for descriptions

\*\*\* New = New dwelling construction; Existing = existing dwelling retrofit

<sup>†</sup> Net Loss

and sewers. The wastewater from the homes in the subdivision is discharged into City of Phoenix sewer mains. Based upon 1 1/2 years of operation, the developers consider all installations to be eminently successful and future installations are planned.

#### Campground

After more than 12 years of operation, the soil absorption system serving a campground in Northern Michigan was no longer able to absorb the daily wastewater flow. In 1976, the campground owners were forced to find a satisfactory method of handling the wastewater flow from restroom and shower facilities serving the 100 site facility. High groundwater prohibited the use of subsurface disposal methods so surface disposal alternatives were considered as well as holding tanks with pumping and offsite disposal. After analyzing the costs and benefits associated with several alternative strategies and considering the seasonal operation of the facility (5 mon/year), the option selected included minimum flow fixtures discharging to holding tanks. Air-assisted toilets (0.5 gal) and low-flow showerheads (2.5 gpm) were retrofitted for the existing conventional fixtures. After six seasons of operation, daily flow reductions of 50-60% have been achieved, there have been no problems associated with the building drains or sewers and all user comments have been favorable. The owners of the campground are completely satisfied with the minimum flow-holding tank option.

#### Recreational Development

A major ski area in Eastern California is served by a complex and expensive wastewater treatment system. With wastewater treatment costs approaching \$2.00/1000 gal, waste flow reduction became a necessity. In the Fall of 1977, a 24-unit housing complex was constructed for ski area employees. Washdown toilets (0.8 gal) and air-assisted showers (0.5 gpm) were installed in all units. The owners calculated that based upon wastewater treatment costs alone, the payback period for the minimum flow fixtures was approximately six months. Experience during 2 1/2 years of operation has been very successful.



### Small Industrial Firm

In November, 1976, a mound soil absorption was constructed to handle toilet and shower room wastes generated by 65 employees of a small industrial firm located in Southeastern Wisconsin [8]. Several expansions during the next three years increased the number of employees to 215 and caused recurrent malfunctions of the mound system. In January, 1980 the average daily flow from the facility was nearly 3000 gpd and the mound was hydraulically overloaded. Effluent in excess of what the mound could absorb was removed from the pumping chamber and hauled offsite for disposal. To help reduce the waste flow below the absorption capacity of the mound, a water conservation program was initiated. Seventeen air-assisted toilets (0.5 gal flush) were retrofitted for conventional toilets in the more heavily used restrooms and manual flush valves were installed on the urinals and automatic shut-off valves were installed on many of the faucets. As a result of these efforts, the average daily flow from the facility was reduced below the capacity of the existing mound system; a 65% flow reduction from 15 gpd/employee to 5.4 gpd/employee.

### SUMMARY

The wastewater flow volume directly influences the design and performance of all onsite wastewater facilities. Daily wastewater flows from homes, motels, offices and other domestic sources can be reduced by 50 percent or more using *minimum flow fixtures* or *water reuse systems*. For most onsite applications however, minimum flow fixtures will usually be more appropriate as they are simpler to install, operate and maintain, present no public health hazards, and possess a lower cost per unit of reduced flow. The minimum flow fixtures and appliances are specially designed products that yield event flow reductions of 50 to 90 percent while accomplishing the same task as their water-consuming counterparts. They are sufficiently similar in appearance and user operation to conventional fixtures that user habit changes are not required.

The dramatic reductions in wastewater flows that are associated with the use of minimum flow fixtures can have significant impacts on onsite wastewater facilities. While further data is necessary before firm

conclusions can be drawn, experience to date indicates the net effects to be beneficial. Additional significant benefits can be derived from the reduced consumption of potable water and energy. These benefits can oftentimes more than offset the relatively higher cost of the alternative fixtures and render the minimum flow approach cost-effective. Experience to date with minimum flow fixtures has demonstrated their successful application under a variety of circumstances. Further development and application on a grander scale is warranted.

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